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It was most unfortunately true a few years ago that many pretended medical cures were described as electric treatments, with the idea of deceiving the unfortunate patients. This is not as serious to-day as it was some years ago, and on the other hand there has been a profitable study of the use of electrical effects in a legitimate way for treating disease. An instructive instance of this kind is described in a recent issue of the *Lancet* in which the practitioner describes his successful use of high-frequency alternating currents to cause electric osmose by means of which drugs were introduced into the tissues of the diseased part. In twenty-two per cent of the cases of cancer treated, the treatment was successful, and he has come to the conclusion that a radioactive salt of strontium induced into the tissues by cataphoresis by high frequency currents would prove the desired panacea for all forms of malignant disease.

SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE.

The series of articles on shop testing of motors and generators appearing in the ELECTRICAL REVIEW should be of interest to the man actually engaged in this work, and particularly so to the student of electrical engineering. The difference between laboratory tests and shop tests is not always made clear. In the factory two classes of work are recognized—the research work which is carried out on a new type of apparatus, and the commercial test through which all apparatus is put to show that it will meet its specifications. The first may be considered a test of design; the latter, a test of workmanship. These points, as well as the proper method of carrying out the tests, the care which must be observed in each case, and the allowable approximations, are all clearly explained in these articles. Mr. Abry is a technical graduate, and has also worked his way up through the testing department of one of our large electrical manufacturing companies. He is thus well fitted to present the subject clearly and instructively.

TEMPERATURE RISE IN RAILWAY MOTORS.

In a paper presented by Dr. Cary T. Hutchinson at the last meeting of the American Institute of Electrical Engineers, a method is described for determining the rise of temperature of railway motors in service, so that for any particular class of service a suitable motor and gearing can be selected. The problem is quite complex, and for this reason various assumptions in regard to operating conditions were necessary, but the results obtained by the method are in satisfactory agreement with those given by actual tests.

Analytical Studies Helpful.

Such studies of electrical machinery are valuable in so far as they enable us to use our machines most effectively. Electrical machinery differs from other machinery in that its capacity is limited, not by the applied voltage or the mechanical strength of the materials, but by the heat which can be dissipated. If a steam engine or other prime mover is overloaded it simply works less efficiently. An electric motor is usually designed to work most efficiently at its normal rating. If it is overloaded it not only operates less efficiently, but its temperature will rise. Such rise may do no damage, unless excessive or prolonged, and for this reason the specifications for electrical machinery frequently call for a machine that will stand a certain overload for a specified time. It is therefore important in laying out the equipment for any particular service that a motor should be selected which is in all respects the best one for that service. It is for this purpose that Dr. Hutchinson has developed his method. This can not be described here, but his paper will be found elsewhere in this issue.

SOME PHASES OF TECHNICAL EDUCATION.

The education of engineers is still receiving a good deal of attention from the technical papers and associations. In England a good deal of uneasiness has been caused by the sharp criticisms made by practising engineers of the English method of furnishing technical instruction. That this agitation is bearing fruit is shown by several reports on technical education which have recently been presented to various bodies. One of these, presented by Principal R. Mullineux Walmsley, to the governing body of the Northampton Institute, is of interest to us because it gives the results of a tour made by Mr. Walmsley with the particular object of investigating the condition of technical education in the United States. An abstract of this report was given in the ELECTRICAL REVIEW of October 31.

Report Favorable to American Schools.

On the whole, the report was favorable to our methods, and decidedly unfavorable to the British lack of method. Some phases of our methods were criticised—perhaps not unjustly. One of these is overloading the student with work of all kinds. In the last two years of the usual four-year courses particularly, the student is forced to take courses in many special branches of his subject, and, from the limited time which can be given, such courses can not be thorough. On the other hand, a good deal of time in the first two years is given to manual training, although the student does not intend to become a mechanician.

Manual Training and Trade Schools Criticised.

The report takes an unfavorable view of our manual training schools and trade schools. The former are thought to attempt too much, endeavoring to compete with the technical college, with the result that they turn out men who do not make good foremen and who are not well prepared to take an engineering course at college.

Objectional Features of Our System.

In an excellent article on technical education in the November issue of the *Engineering Magazine,* Dr. Louis Duncan also criticises our system. He lays stress upon the evil effects of attempting to instruct the student too much, leaving too little to the man himself. He believes too much time is given to lectures and the study of text-books. It does not seem to be considered that information, as such, is not of great importance. What should be attempted is to make the men mental factories, and not mental storehouses. For this reason Dr. Duncan does not think that the most elaborately equipped institutions can point to a seemingly proper proportion of really successful graduates. Such institutions attract large classes, with the result that the instructor is not able to give as much personal attention to the individual members as is desirable. In handling such large classes much of the work becomes mere routine. On the other hand, these elaborate equipments bring the student into contact with practical machines, and not mere toys. There is, however, one possible drawback to elaborate equipments: Technical schools can not afford to scrap their machinery as soon as it is out of date, and if electrical machinery develops as rapidly within the next ten years as it has in the past ten years, it will not be long before many laboratory equipments which are excellent to-day will be antiquated. These machines will still have an educational value, but will no longer conform to the practice of the day.

Training of the Imagination Neglected.

Another point upon which Dr. Duncan lays particular stress is the cultivation of the imagination. This is a matter which is seriously neglected in our present school systems. The student insists upon having a machine or a drawing to assist him in the simplest problems, and he does not develop the faculty of picturing to himself the conditions of the problem. The trouble probably starts in the primary school, or even in the kindergarten. The child is taught not to count, but to count blocks, and the teacher will not venture to talk about a cat unless she can show one to the class, and the same system is used too much throughout all the schools. This is wrong, for training the imagination is important in all education, but particularly so in developing an engineer. Real engineering work consists in solving new problems, in devising and perfecting new machinery and methods, and in this work a well-trained imagination is essential for success.

PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

Next in importance to the fixing of electrical units is the construction of practical standards of such form and material that they will be permanent and can be tested and used conveniently. Specifications for such standards are usually drawn up by some authoritative body after mature thought and painstaking study of such data as is obtainable and which in any way bears upon the construction and behavior of the proposed standard. When a decision of this kind has been reached, the standard must then be considered on probation. Several such standards are constructed with the greatest care, and these are preserved and a record of each is carefully kept. Upon this record much depends, and it is not sufficient that the standard should be watched for a few months or a few years, but for a long period of time. And, at the same time, other suggested standards and methods of construction should be examined with reference to the accepted standard, with a view of determining whether the proposed standard can be constructed more accurately than the old, whether it would be less liable to change, and, as a minor consideration, whether it would be more convenient.

The Standard of Electromotive Force.

To illustrate this point, it may be mentioned that at the International Electrical Congress, which will be held at St. Louis next year, the question will probably be brought up of replacing the Clark cell—which is the legal standard of electromotive force to-day—by the cadmium cell. The objections to the Clark cell are that it is troublesome to construct, it is seriously affected by impurities in the materials used; it has an odd value and a high temperature coefficient, and, most serious of all, the accuracy of its legal value is in question. The cadmium cell which is proposed in place of the Clark is not so troublesome to construct,

has a value near unity and an almost negligible temperature coefficient, advantages worth consideration, though they may not be sufficient to cause the Clark cell to be discarded. Whatever the outcome of this attempt to change the legal standard, it should be remembered that it is not the absolute value of the volt which is in doubt, but the actual electromotive force developed in the Clark cell and the question to be decided is whether the cadmium cell is not the more convenient form of apparatus.

Record of the British Association Standards of Resistance.

Of equal importance with the selection of a standard of electromotive force is that of selecting a standard of resistance. In 1898 independent determinations of the value of an ohm were made in this country, in England and in Germany. From the average of the three values it was decided that a column of mercury one square millimetre in section and 106.3 centimetres in length, would have a resistance of one ohm at 0 degree centigrade, and the resistance of such a column of mercury has been defined as the international ohm. The construction in this way of a resistance is difficult, and the apparatus is of such a character that it can not be used conveniently. For this reason, standards of resistance are usually constructed of some metal or alloy supposed to be little subject to change. Such standards must be watched carefully during their existence with a view to detecting any change. An instructive study of such resistances is given in a report of a committee to the British association, which was presented at the annual meeting of the association at Southport, in September, and which gives a record of the standards preserved at the British National Physical Laboratory. It appears from this report that changes have shown themselves in all the original silver-platinum coils. The relative values of these coils have been discussed in previous reports to the British association, the 1888 report containing a very complete comparison of all the earlier coils. It was shown then that they agreed with the values assigned to them by Fleming in 1881. The conclusion was therefore drawn that, with the exception of the platinum-iridium coils, no really certain variations could be traced in the other coils. In reports made in 1890 and 1892, however, changes in three of the standards had been recorded. One standard remained unchanged in value until 1901.

Reasons for Changes.

The reasons for these changes are difficult to trace. In some cases the change may be due to a removing of the coil to another place for making new determinations of its value. Changes in certain coils appeared after the coils had been subjected to a very low temperature, which may have started strains. It appears from the report that the new platinum-silver standards have retained their values since 1898, practically unchanged.

Comparison of Various Standards.

The present report also gives a comparison of the British standards and those of the Reichsanstalt, the results indicating that the unit of the British association is less than that of the Reichsanstalt by 0.000105. This result is deduced from a series of experimental concordant measurements on coils of six different values—one-tenth, one, ten, 100, 1,000 and 10,000 ohms. Both the unit and the multiple coils agree in giving the same difference in the Reichsanstalt and British standards.

Accuracy of the International Ohm Questioned.

From a study of the records, the committee has come to the conclusion that the length of the mercury column constituting the international ohm—which has been defined as 106.3 centimetres—does not give the absolute value. The absolute unit, as deduced from the coils of the association, has a length of 106.291 centimetres, and thus the absolute unit is thought to be smaller than the international ohm by 0.009 per cent. The report concludes that the British Board of Trade unit of resistance is too small by 0.015 per cent. Should further investigations, now in progress, confirm the deductions drawn in this report, would it not be well for the International Electrical Congress, in addition to the consideration of a new standard of electromotive force by it, to consider the appointment of a committee to redetermine the absolute value of the ohm and to make investigations with a view of deciding upon suitable methods of constructing working standards?

SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE—V.

BY BERTRAND B. ABRY.

3—SPEED TEST.

Before beginning this test the cold resistance should be measured if not already obtained. This is done by the fall of potential method as explained earlier. These resistances are reduced to a basis of twenty-five degrees centigrade on the assumption that two and one-half degrees centigrade is equivalent to a change of one per cent in the resistance. This resistance at twenty-five degrees centigrade is then increased a certain amount corresponding to the average temperature at which the motor will probably run when in service. This was fully explained under direct-current generators.

To conveniently make this test the motor should be direct-connected to a similar machine driven as a generator and feeding into a rack. In this way the load may be readily varied.

During the test make the following motor observations:

Speed.	Main Volts	Amperes.	Field Volts.

Throughout the test keep the main voltage constant. After the test has been completed correct the speed observed, to correspond to the above average temperature at which the motor will probably run in service. This correction is made on the following basis:

It is assumed that the total drop in voltage (*i. e.*, across armature and field) is to drop across the field alone, as the total resistance of the motor is to the resistance of the field alone. That is, the current being constant the voltage varies directly as the resistance. For convenience tabulate and designate the calculation, as follows:

Amperes. (*a*)	Main Volts. (*b*)	Field Volts. (*c*)	Total Observed Drop. (*d*)	Total Calculated Drop. (*d'*)	Observed Effective Volts. (*e*)	Calculated Effective Volts. (*e'*)	Observed Speed. (*s*)	Calculated Speed. (*s'*)

Then according to the above assumption,

$$(d) : (c) :: (R_a + R_f) : R_f$$

or,

$$(d) = (c) \times (R_a + R_f) / R_f$$

but

$(R_a + R_f / R_f$ is a constant at any given temperature, such as the average temperature of the motor in service as referred to above.

Therefore

$$(d) = (c) \times K$$

Also

$$(d') = (a) \times (R_a + R_f)$$

$$(e) = (b) - (d)$$

and $(e') = (b) - (d')$

Then since the speed varies with the voltage, the following relation holds:

$$(s') : (s) :: (e') : (e)$$

that is,

$$(s') = (s) \times (e') / (e)$$

In this manner the corrected speed is obtained for the increased temperature at which the motor will probably run in service. Seventy-five degrees centigrade is generally taken as a safe working limit for railway motors.

Having thus corrected the speed for different loads, plot it, using revolutions per minute and ampere as co-ordinates of the curve. A curve of the general shape shown in Fig. 13 will result, and should be marked "Speed at, say, seventy-five degrees centigrade."

4—BRAKE TEST.

The brake test on a series motor is made in very much the same way as in the case of shunt and compound motors. The torque may be conveniently measured by means of a Prony brake. It is difficult to get accurate speed readings during a brake test and it is not necessary to observe the speed if a speed test has already been made and the results corrected and plotted as in Fig. 13.

Make the following observations:

Volts.	Amperes.	Torque.	Calculated Speed (as Obtained from Speed Test).

Hold the voltage constant throughout the test and vary the current, that is, the load. After the test has been made, obtain from the speed curve the corresponding speed values, and reduce the torque to pounds at one-foot radius.

Make a careful preliminary plot of this speed and torque on an ampere base. From these preliminary curves choose even values of the amperes for convenience, and read corresponding values of the speed and torque. Tabulate the results as follows:

Amperes.	Corresponding Speeds.	Torque.	Brake H.-P.	Electric H.-P.	Efficiency.

Knowing the speed and torque, the brake horse-power may be computed from the formula:

B. H.-P. = speed × torque × $2\pi/33{,}000$
= speed × torque × 0.0001904

where torque equals pounds pull at 1′ radius.

The

E. H.-P. = amperes × volts / 746.

Lastly, the efficiency is computed from

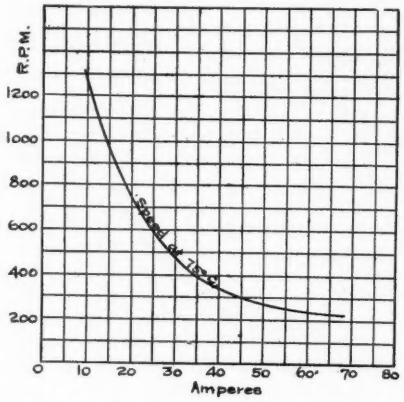


FIG. 13.—SPEED CURVES—SERIES MOTOR.

the ratio of the brake horse-power to the electrical horse-power. After these calculations have been made the characteristic curves may be plotted altogether, as shown in Fig. 14. These curves are plotted on an ampere-input base; consequently at zero amperes, we have zero electrical horse-power. In other words, when the voltage is held constant, the electrical horse-power varies as the current and we get a straight line curve through the origin.

The torque and brake horse-power

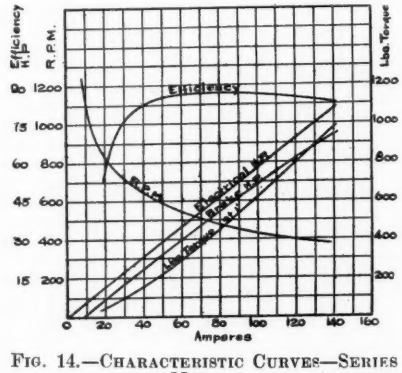


FIG. 14.—CHARACTERISTIC CURVES—SERIES MOTOR.

curves start a little above zero amperes, because the losses must first be supplied before power can be obtained from the motor. Notice also that the general shape of the brake horse-power curve is convex, and that it tends to fall away from the electrical horse-power curve, the heavier the load. The difference of the ordinates of these two curves represents, of course, the loss in the motor at any given load. This greater difference, the larger the current, is due chiefly to the fact that the copper loss on heavy loads increases very fast, and is a large percentage of the total loss.

The curves in Fig. 14 are not drawn to exact scale, but when accurately plotted it will be noted that the torque increases much faster than the current, and approximately in this ratio three times the torque at double the current.

The efficiency curve is in all cases convex in general form. The downward tendency of the curve at overloads is due to the rapidly increasing losses. It is customary to plot only that portion of the curve as shown, but when drawn in full it crosses the X axis at zero brake horse-power.

As a check upon the efficiency obtained from the brake test, the efficiency may be calculated from the losses in a manner similar to that explained under shunt and compound motors. In the case of a series motor, however, the same current goes through the armature and field, hence the C^2R loss in armature and field may be calculated as one loss. The iron, friction and windage loss may be obtained from the iron loss and friction curve for the different current values taken. With these exceptions the method of calculating the efficiency from the losses for a series motor is similar to that used for the shunt motor.

These characteristic curves of a railway motor obtained from a shop test give all the information desired in connection with the application of the motor to actual service, when the armature speed has been reduced to miles per hour, and the torque at one-foot radius to tractive effort at the rim of the car wheel.

In figuring the size of motor required for any particular railway service, it is more convenient to know what pounds pull the motor will exert at the rim of the car wheel, that is, the tractive effort. This tractive effort at the rim of the wheel varies directly as the torque at one-foot radius, directly as the ratio of the gear to the pinion, directly as the efficiency of the gears, and inversely as the radius of the car wheel. We may write this in the form of an equation, as follows:

Tractive effort =
Torque (at 1′ radius) × gear / pinion × 1′ / radius wheel × efficiency of gears.

With the aid of this formula we may calculate the tractive effort curve for any size wheel and any gear ratio. It is then customary to plot the characteristic curves, replacing the torque by the tractive effort curve, which is of the same general shape.

EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS—I.[1]

During the year a very complete comparison of the resistance standards belonging to the association has been carried out, and the standards have been compared with those of the Reichsanstalt and of the Board of Trade. The various units discussed in the report are: (1) The "ohm" 10^9 C. G. S. units of resistance; (2) the international ohm—*viz.*, the resistance at 0 degree C. of a column of mercury of uniform section 106.3 cm. in length and 14.4521 grammes in mass; (3) the original B. A. unit; (4) the Board of Trade unit, supposed to represent the international ohm, but constructed in 1891 so as to be equal to 1.01358 B. A. units; (5) the N. P. L. unit defined as No. 4, as deduced from the wire standards of the association; (6) the Reichsanstalt unit, constructed at the Reichsanstalt to represent the international ohm; (7) the mercury tubes, constructed at the National Physical Laboratory to represent the international ohm.

A full account of this comparison is given in Appendix I to the report, by Mr. F. E. Smith, of the National Physical Laboratory. It appears from this that changes have shown themselves in all the original platinum-silver coils. The relative values of these coils are discussed in the reports of the committee for 1888, 1890 and 1892. The 1888 report contains a very complete comparison of all the coils, not merely those of platinum-silver; and it is there shown that they then agreed with the values assigned to them by Fleming in 1881. The conclusion is also drawn in the same report that, with the exception of the platinum-iridium coils A and B, no really certain variations could be traced in the other coils between the results of Matthiessen and Hockins comparisons in 1864 and 1867, those of Chrystal in 1876, Fleming in 1881, and the present secretary[2] in 1888. A postscript to the report for 1888 recorded, however, an appreciable change in the coil F in the autumn of that year. In Appendix I Mr. Smith starts with the values given in the 1888 report, which are, as nearly as we can tell, the original values of the coils.

[1] Report of a committee of the British Association, consisting of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Lord Kelvin, Professors W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver Lodge, Dr. A. Muirhead, Sir W. H. Preece, Professors J. D. Everett, A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Professor S. P. Thompson, Mr. J. Rennie, Dr. E. H. Griffiths, Sir A. W. Rucker, Professor H. L. Callendar and Mr. George Matthey. Presented at the annual meeting of the British Association at Southport.

[2] It is possible that coil F is an exception to this statement.

Changes in the three standards F, G, H have already been recorded in previous reports (1890 and 1892). The standard coil Flat remained unchanged in value until 1901-1902. Between the observations recorded in these years it increased in resistance by 17×10^{-5} B. A. U., and has not varied since. The alterations in the other coils, since the comparisons in 1888, have been as follows: (F) $+ 97 \times 10^{-5}$ B. A. U.; (G) $+ 33 \times 10^{-5}$ B. A. U.; (H) $+ 18 \times 10^{-5}$ B. A. U. It should, however, be noted that while between 1888 and 1890 the change in F was $+ 64 \times 10^{-5}$ B. A. U., that in G was $- 27 \times 10^{-5}$, and in H $- 13 \times 10^{-5}$. Since 1890 the same coils changed by $+ 33 \times 10^{-5}$, $+ 54 \times 10^{-5}$ and 31×10^{-5} B. A. U., respectively, while between 1901 and 1902 Flat, as has already been stated, rose by 17×10^{-5} B. A. U. It is not easy to trace the causes of these changes. In the case of Flat the observations in 1901 were made at Kew, those in 1902 at Bushy House, and the change may in some way be connected with the removal of the coils. The changes in F, G, H first showed themselves after the coils had been subject to a very low temperature, and may have been started by strains due to this. Appendix I gives the details on which these various statements are based. It appears also from the same appendix that the new platinum-silver ohm standards of the association have retained their values since 1898 practically unchanged.

The comparison between the standards of the association and those of the Reichsanstalt leads to the result that the unit of the association (No. 5 of those defined above) is less than that of the Reichsanstalt (No. 6) by 0.000105 ohm. This result is deduced (table IX of Appendix I) from a series of extremely concordant measures on coils of value 0.1, 1, 10, 100, 1,000 and 10,000 ohms; thus both the unit and the multiple coils agree in giving the same difference between the Reichsanstalt and ourselves.

By the kindness of Mr. Trotter a comparison has been made between the Board of Trade unit and those of the association, with the result that, as deduced from the unit coils, the Board of Trade unit is less than that of the association by 0.00006 ohm. This result, however, is not confirmed by a comparison of a 1,000-ohm coil belonging to the association with one of those of the Board of Trade;[1] these coils show no difference.

The above statements are made on the assumption that the various changes in the coils which have undoubtedly occurred have been rightly interpreted, so that we can now recover the absolute C. G. S. value of the coil Flat, and hence of the standard ohm as originally determined at the Cavendish Laboratory, and defined by the committee in the Edinburgh Report, 1892. That this is the case is borne out by the results of the experiments on the specific resistance of mercury, a summary of which is given in Appendix II. These are not yet complete. Mr. Smith has, however, constructed and calibrated eleven mercury tubes. The mean cross-section of each of these has been determined by at least four different sets of measurements. In nine cases the greatest difference between any measurement and the mean is not more than 0.001 per cent. The values found for the resistance of each tube do not differ by more than 0.001 per cent.

If we assume as above that the values of the wire standards of resistance of the association are known in terms of the absolute C. G. S. unit, then it follows that the length of the column of mercury, 1 sq. mm. in section, which would have a resistance of 10^9 C. G. S. units, would be 106.291 cm. The value found for this same quantity by the secretary (Mr. Glazebrook) and Mr. Fitzpatrick in 1888,[1] was 106.29 cm. We infer then that we still can recover from our standard coils the absolute C. G. S. unit of resistance. Again, the length of the mercury column constituting the international ohm has been defined as 106.3 cm. But we have seen that the absolute C. G. S. unit, as deduced from the wire coils of the association, has a resistance equal to that of 106.291 cm. Thus the absolute unit[2] is smaller than the international ohm by 0.009 per cent. Again, it has been stated above that the unit deduced from the standards of the association is smaller than that of the Reichsanstalt by 0.0105 per cent. Thus the mercury standards of the Reichsanstalt, constructed to represent the international ohm, exceed those just made for the association by Mr. Smith by $0.001 1_5$ per cent, or 1.5_5 parts in 100,000.

Again, if these results be accepted, since the Board of Trade unit as derived from the wire standards is less than that of the association by 0.006 per cent, and the association unit is too small by 0.009 per cent, it follows that the Board of Trade unit is too small by 0.015

[1] If the view be accepted that the laboratory unit is the same as in 1891, the Board of Trade standard has fallen since that date by 0.00006 ohm.

[1] *Phil. Trans.*, 1888.

[2] The resistance taken for a column of mercury 1 sq. mm. in section, 100 cm. in length at 0 degree C. at the Edinburgh meeting in 1892 was 0.9407×10^9 C. G. S. units. Mr. Smith's experiments give, assuming the values of the wire coils known, the result 0.9408×10^9 C. G. S. units.

per cent. This difference arises in part from the fact that the standards of the association, from which the Board of Trade standard was copied by the secretary in 1891, are too low; in part from the fact that the Board of Trade standard has diverged slightly from that of the association since 1891.

Thus, to sum up this part of the report, it may be stated that:

(*a*) The original B. A. unit and the standard ohm based on it (Nos. 3 and 5 of the units concerned) can be recovered from the wire coils of the association.

(*b*) The Board of Trade unit (No. 4) is now less than the laboratory unit (No. 5) by 0.006 per cent.

(*c*) The laboratory unit (No. 5) is less than the international ohm (No. 2) by 0.009 per cent.

(*d*) The Board of Trade unit is less than the international ohm by 0.015 per cent.

(*e*) The mercury tubes made at the National Physical Laboratory to represent the international ohm are less than those made at the Reichsanstalt by 0.0015 per cent.

This last result must be considered as provisional pending the completion of Mr. Smith's work, but it is clearly highly satisfactory.

Mr. Smith has also made progress during the year with his investigations into certain of the anomalies shown by Clark cells, but the results of that enquiry are not yet ready for publication.

The standard condensers of the association have been frequently in use during the year; about 15 condensers have been compared with them. They retain their value in a satisfactory manner, and are convenient to work with, though possibly some improvement in the insulation might be desirable. A chronograph, purchased with part of the grant made last year, will enable the time measurements required in the measurements of capacity to be made with greater accuracy, and hence will permit of greater rigidity in the enquiry as to the permanence of the standards.

The platinum thermometers made from the stock of wire purchased from Messrs. Johnson and Matthey, which at the time of last report were in course of construction, have been completed, and the behavior of some of them investigated throughout the past year. The resistance box available was the old Callendar-Griffiths box used in the work of Dr. Chree at Kew Observatory, having coils of platinum-silver on the binary system. The contacts are an old form of the Cambridge Instrument Company's type of plug contact, the cheeks being made of a special white alloy held in round Doulton-ware cups. In measurements with this box not much significance attaches to the third figure of decimals representing hundred-thousandths of an ohm, though the settings could be made to this amount at the lower temperatures. The box resistance coils were intended for use with platinum thermometers of 1 ohm fundamental interval only, and therefore the two high-resistance thermometers, of 5 ohms fundamental interval, could not be measured at the sulphur-point; their systematic investigation has, therefore, been temporarily postponed. The want of a better box for this work is seriously felt.

Of the original six thermometers made in August, 1902, Nos. 1 to 4 are of 1 ohm fundamental interval, Nos. 1 and 2 being in porcelain and 3 and 4 in specially thin Jena glass tubes of internal diameter 8 mm. to 9 mm. and 38 cm. to 40 cm. long. Nos. 5 and 6 are of 5 ohms fundamental interval and in somewhat wider tubes of specially thin glass, through which the four leads are hermetically sealed. The heads of all these thermometers are of the design used by Chappuis and Harker, the contacts to the solid ends of the copper flexibles being made by fusible metal cups. With reasonable care these contacts prove very satisfactory, both as regards the constancy of their resistance and their mechanical strength. In the construction of all these thermometers special care was devoted to adjusting their fundamental intervals to be very close to their nominal values, and after completing this adjustment all were subjected to repeated annealing in air at a bright-red heat, thermometers Nos. 3 and 4 being temporarily placed in porcelain tubes for the purpose.

The remaining four constructed last summer, and one of later date, all of 1 ohm fundamental interval, have had their constants determined from time to time during the year. One of them—B. A.$_2$—was selected as a representative platinum thermometer for use in an investigation made to determine the relation between the platinum scale and that of the gas thermometer of the National Physical Laboratory at temperatures up to 1,000 degrees C. During the time occupied by two sets of experiments with this instrument, extending over about three months in all, its constants altered by an amount only just greater than their probable error, showing that it is quite possible to use properly constructed platinum thermometers up to temperatures slightly over 1,000 degrees C. for long periods without fear of serious changes.

The summary of the life history of the different thermometers is given in Appendix III. The chief fact apparent is that there seems to be a small but real difference between the δ of thermometers 1 and 3 on the one hand, and 2, 4 and 7 on the other, the maximum divergence being about 0.02. Prolonged electrical heating in air of the wire of one of the thermometers was not found to sensibly change the value of the δ. The cause of the small differences found is not obvious, and further investigation is being made on this point. A change in δ from 1.50 to 1.51 would make at the sulphur-point a difference of 0.153 degree C., and at 1,000 degrees C. one of 0.9 degree.

The question of the resistance of copper has been raised lately by the work of one of the subcommittees of the Engineering Standards Committee. For commercial purposes the resistance of copper is defined at a temperature of 60 degrees F. (15.55 degrees C.). A table in Appendix IV gives the values that have been found by various experimenters. It is clear that copper is now prepared of a higher degree of purity than in the time of Matthiessen. Taking the mean of the figures in the table for modern electrolytic copper, we have as the value of the resistance of 1 metre of copper wire weighing 1 gramme at 15.55 degrees C. the value 0.1485_5 ohm, but the figures of which this is a mean range from 1,475 to 1,492. The value found by Matthiessen, as deduced from his paper in the *Phil. Trans.* for 1860, is 0.1500 ohm. Thus the conductivity of modern pure electrolytic copper is 1 per cent better than Matthiessen's. The committee on copper conductors, which investigated the question in 1899, adopted the number of 0.1508 ohm as the resistance of a metre-gramme of commercial annealed high-conductivity copper. This figure has been accepted by the Engineering Standards Committee.

Mr. H. A. Taylor has recently placed in the hands of the secretary two resistances of gold-silver wire made by Mattheissen himself, to represent the resistance at 15.5 degrees C. of 100 in. of pure annealed copper, having the weight of 100 grains. The resistances of these coils have been determined by Mr. Smith, and the results are given in the following table:

	Coil No. 1.	Coil No. 2.
Resistance of 100 in. of copper weighing 100 gr., as given by Matthiessen in B. A. units at 15.5 degrees C.	0.1516	0.1514
Resistance found in 1903 in B. A. units at 15.5 degrees C.	0.1513_5	0.1513_2
Resistance found reduced to ohms at 15.5 degrees C.	0.1493_2	0.1492_9
Resistance deduced of a metregramme in ohms at 15.5 degrees C.	0.1499_6	0.1499_4

Thus Matthiessen's value for the resistance of annealed copper at 15.55 degrees C. (60 degrees F.) as deduced from these coils, agrees very closely with the value calculated by the secretary from the figures in his 1860 paper.

(To be continued.)

1,600-Horse-Power Gas Engine and Three-Phase Alternator at Laar Power Plant, and Other High-Power Blast Furnace Gas Engines.

By Frank C. Perkins.

THE progress in the development of the high-power gas engine has been most rapid during the past two or three years, especially on the continent of Europe, where thousands of horse-power are developed at the present time in the electrical power stations of foreign iron and steel plants; utilizing the waste blast furnace gas, which has heretofore been a total loss, although in some instances it has been employed for fuel for boilers which have supplied steam engines, driving blowers and electrical generators.

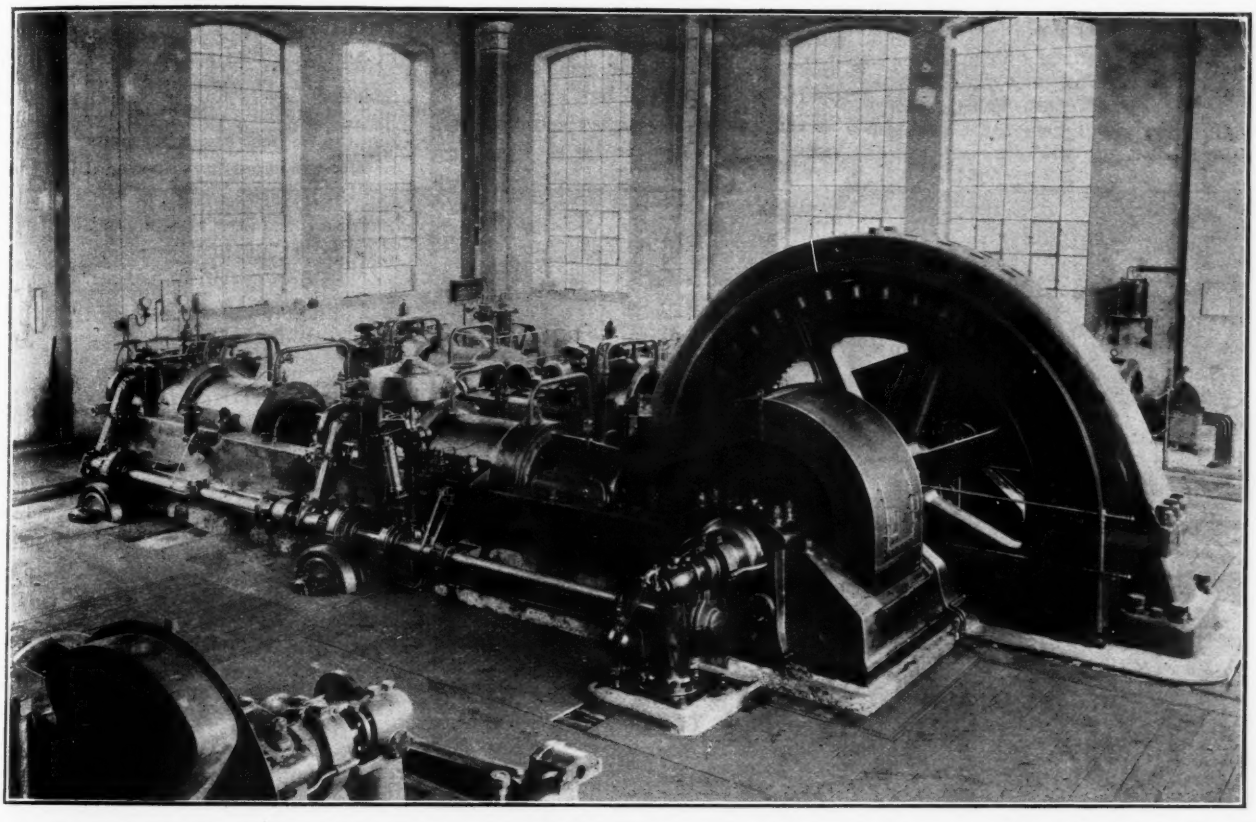


FIG. 1.—THREE-PHASE GAS ENGINE, POWER PLANT OF PHŒNIX ACTIENGESELLSCHAFT FÜR BERGBAN UND HUTTENBETRIEB AT LAAR, NEAR RUHRORT. 1,600 HORSE-POWER, 4-CYLINDER GAS ENGINE, DIRECT-CONNECTED TO A THREE-PHASE ALTERNATOR.

Until recently single-acting four-cycle engines have been more extensively used for this purpose, ranging in capacity up to 1,000 horse-power for single cylinders and 2,000 horse-power for double cylinders, arranged one on either side of the flywheel or in tandem on the same side of the flywheel or generator. In some cases higher output has been obtained by double-tandem arrangement, using a single-acting tandem engine on each side of the alternator. Such an arrangement is illustrated in Fig. 1, showing two 800-horse-power tandem engines, both directly coupled to a three-phase alternator, which, when operating at full capacity, absorbs fully 1,600 horse-power. This is one of the gas engine units at the power station at Laar, near Ruhrort, and is operated by the Phœnix Actiengesellschaft Für Bergbau Und Huettenbetrieb. This double-tandem gas engine has four cylinders and was built by the Vereinigte Maschinenfabrik Augsburg Und Maschinenbau-Gesellschaft Nurnberg.

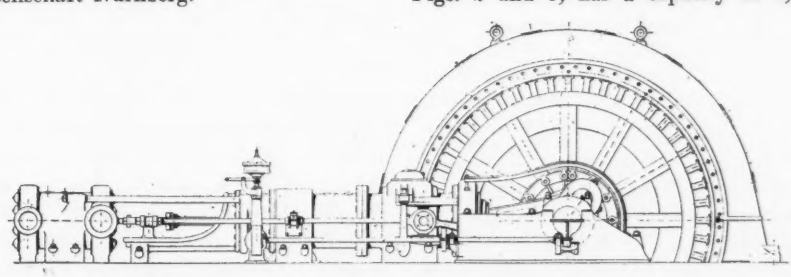


FIG. 2.—DOUBLE-CYLINDER GAS ENGINE, DIRECT-CONNECTED TO THREE-PHASE ALTERNATOR.

Another double-cylinder gas engine of high power directly connected to a three-phase alternator is shown in the drawings, Figs. 2 and 3. These engines operate on the Oechelhaeuser system of two stage motors and have two plunger pistons working toward each other in a single cylinder which is open at both ends. These pistons shortly before reaching their dead points open successively the different ports, the exhaust port first, then the port for rinsing the cylinder with fresh air and finally the gas inlet port.

The large double-cylinder gas engine of the Oechelhaeuser type, noted in diagram Figs. 2 and 3, has a capacity of 1,000 horse-power and is in operation at the power plant of the Ilsedes-Hütte in Grossilsede, near Hanover, Germany.

Besides the tandem types of single-act-

ing gas engines, one of which is seen in Fig. 4 having a capacity of 600 horse-power and arranged for direct-connection to an electrical generator, there are also double-acting gas engines now constructed which give most excellent regulation for driving alternators in parallel. This is largely true on account of the fact that there is an impulse at every stroke and at each end of the cylinder. Double-acting gas engines are now constructed abroad using both the four-cycle or Otto cycle and the two-cycle or Clerk cycle. The double-acting engines of Koerting Brothers are now constructed in this country as well as in Europe in capacities up to 2,000 horse-power with a thermal efficiency of thirty-eight per cent.

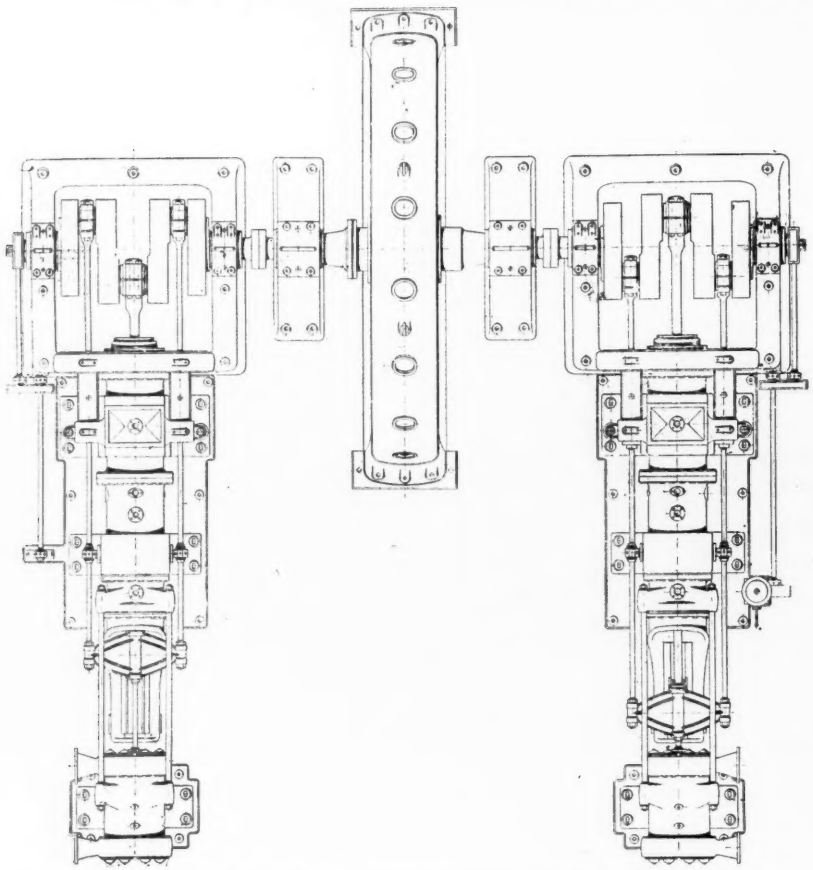


FIG. 3.—DOUBLE-CYLINDER GAS ENGINE, DIRECT-CONNECTED TO THREE-PHASE ALTERNATOR.

Double-acting four-cycle engines are now being constructed by John Cockerill, of Seraing, Belgium, of 3,000-horse-power capacity, and double-tandem double-acting engines of the same type have been designed by this firm for a capacity of 6,000 horse-power.

The Oechelhaeuser gas engine has two plunger pistons working toward each other in a simple cylinder. After the explosion of the compressed and mixed gases, such a large quantity of the burned gases escapes that the pressure in the cylinder sinks as low as the atmosphere and then the entering fresh air blows out the remainder of these gases through the exhaust pipe. A yielding cushion is thus formed between the hot exhaust gases and the fresh ones before the fresh supply of gas enters and mixes with the air entering and forming with the latter the explosive mixture. The explosive mixture is then compressed by the two pistons nearing each other and the ignition takes place just before the end of the compression. This drives the pistons from each other and the entire cycle is again repeated and so on indefinitely.

A feed pump is attached to the engine which supplies the air and fresh gas which are compressed in the receivers arranged around the ports to such an extent that there is effected a sufficient rinsing of the cylinder as well as a good mixing of air and gas. The pistons shortly before reaching their dead points open successively the different ports, the exhaust port, the port for rinsing the cylinder by fresh air, and the gas inlet. The power is regulated in a similar manner as is done in steam engines by the throttle valve, a single admission valve regulating the gas supply to the pump and therefore the number of revolutions.

It will be observed that the cylinder itself has no valve operating during the piston stroke and the engine is thus very favorable to the exacting conditions of work in using blast furnace waste gases. The oiling of the working cylinder is so arranged that in no position of the pistons are the oil holes left free by the latter, and the pistons as well as the cylinder walls are continually supplied with an abundance of lubricant. The working cylinder is fastened in the cooling chamber in such a way that its free expanding by the heat is effectually secured, the cooling spaces also being brought close to the receivers for air and gas.

An Oechelhaeuser blowing gas engine of this type having a working cylinder thirty and one-half inches in diameter and a stroke of thirty-seven and three-eighths inches, has a maximum capacity of 800 indicated horse-power. The blowing cylinder is seventy-two and one-half inches in diameter and is capable of compressing 17,662 cubic feet of air per minute to a pressure of 7.7 pounds per square inch, at the normal speed of 100 revolutions per minute.

Dielectric Hysteresis.

Work has recently been carried out at the laboratory of the Elektricitäts Actien-Gesellschaftvorm W. Lahmeyer und Compagnie by Mr. P. Holitscher in studying dielectric hysteresis and the heating of high-tension cables. With a view to obtaining these losses, independent of the volume of the materials, experiments were made on high-tension machines. One of the difficulties of the work was the designing of a measuring method which would give accurate determinations of the small power involved. Mr. Holitscher's work has shown that a relatively accurate and convenient method for determining great losses by dielectric hysteresis, as is the case with the great strain of the dielectric, is obtained by applying to the capacity to be tested the high potential of a transformer, the loss of the transformer being deducted from the input supplied to it. With smaller losses, measurements are made direct in the high-tension circuit by means of a wattmeter, the low and high-tension coils of which are interchanged, and incandescent lamps inserted as a shunt resistance in the pressure circuit. The losses met with are practically proportional to the number of periods, a loss by leakage of current being practically negligible as compared with dielectric hysteresis. The capacity, and therefore the dielectric constant, was by no means a constant quantity with the material tested—micanite. It was altered within appreciable limits according to the elec-

trostatic strain. As the variation of the capacity was an unknown quantity, it was impossible to determine in anticipation the increase of the dielectric hysteresis with the increase of the pressures. In high-tension machines with micanite tubes, the dielectric hysteresis loss with higher strains on the micanite is approximately proportional to the third power of the tension. In determining the efficiency of a high-tension machine, the loss by dielectric hysteresis is negligible, as comparatively thick material is generally chosen to provide against piercing.

Underground Telegraphs.

The British Post Office will complete the putting underground of the telegraph system between Warrington and Carlisle, and Manchester and Leeds. The cost of the work, together with a twenty-mile extension to Beattock Rise, is estimated at $675,000. The three new sections referred to cover about 120 miles, and the cost is considerably less than a few years ago, as the 113 miles from London to Birmingham cost $800,000. Practically all the exposed parts of England will be dealt with in this manner before the end of the year. The authorities are urging on the contractors to complete the new pipes along the northwest route to Glasgow and Edinburgh, and it is probable that the underground system will be extended in the direction of Portsmouth, Bristol and Land's End, as recent storms have shown the susceptibility of the wires in the south of England.

A Heavy Electromobile Tractor.

A heavy electromobile tractor is now in use at Grevenbruck, Westphalia, for hauling heavy loads, and has proved quite successful. This tractor, or road locomotive, has the advantage of not requiring a regular track, but is built to run over the ordinary roads. It is used for hauling loads of material from a large brick factory over the main road to the nearest railroad station, which is about half a mile distant. The tractor is equipped with two motors of twenty-five to thirty horse-power each. The current is taken to the motors from a double overhead wire by a special form of trolley which is supported on the roof of the tractor. This trolley, which is the invention of M. Schiemann, is constructed so that it can shift from side to side upon its base so as to cover a distance of ten feet or more, while still keeping a contact with the overhead wire. By the use of this device the train composed of the locomotive and its trailers can easily pass around a curve of twenty-two-foot radius, such as occur frequently in the present case. The tractor usually draws a train of two freight cars which carry a load of five tons each. The gross weight of a loaded train is about twenty tons, of which one-half represents the net load. In some cases the tractor draws a train of four freight cars. The average speed of such a train is four miles an hour. As to the energy required for the locomotive, it is found that with the best conditions of road surface it requires about 350 volts and thirty amperes.

Motor Cars for Railways.

The use of self-propelled or so-called motor cars on railways is still attracting a good deal of attention in England. The current issue of the *Railway News* describes two cars just put in service on the Great Western Railway, running between Chalford and Brinscombe. The cars are fifty-seven feet long, eight feet six and three-quarter inches wide, and eight feet two inches high inside. The total wheel base is forty-five feet six inches. The wheel base of each truck is eight feet. The car is divided into a compartment thirty-nine feet long for passengers, one for the motor, twelve feet nine inches long, and a vestibule four feet long. The car is handsomely finished inside and out, comparing in this respect to the best type of electric car, and will accommodate fifty-two passengers. It is propelled by means of a steam motor, with cylinders twelve inches by sixteen inches, fixed horizontally on the frame of the truck. The diameter of the driving wheels is three feet eight inches. The tractive force is 8,483 pounds. Steam is supplied by a vertical boiler burning coal. The working pressure is 180 pounds. This car has been put in service to meet competition with the electric lines and to build up local traffic. It stops at road crossings, as well as the fixed stations. The cost of the cars is given as $12,500 each.

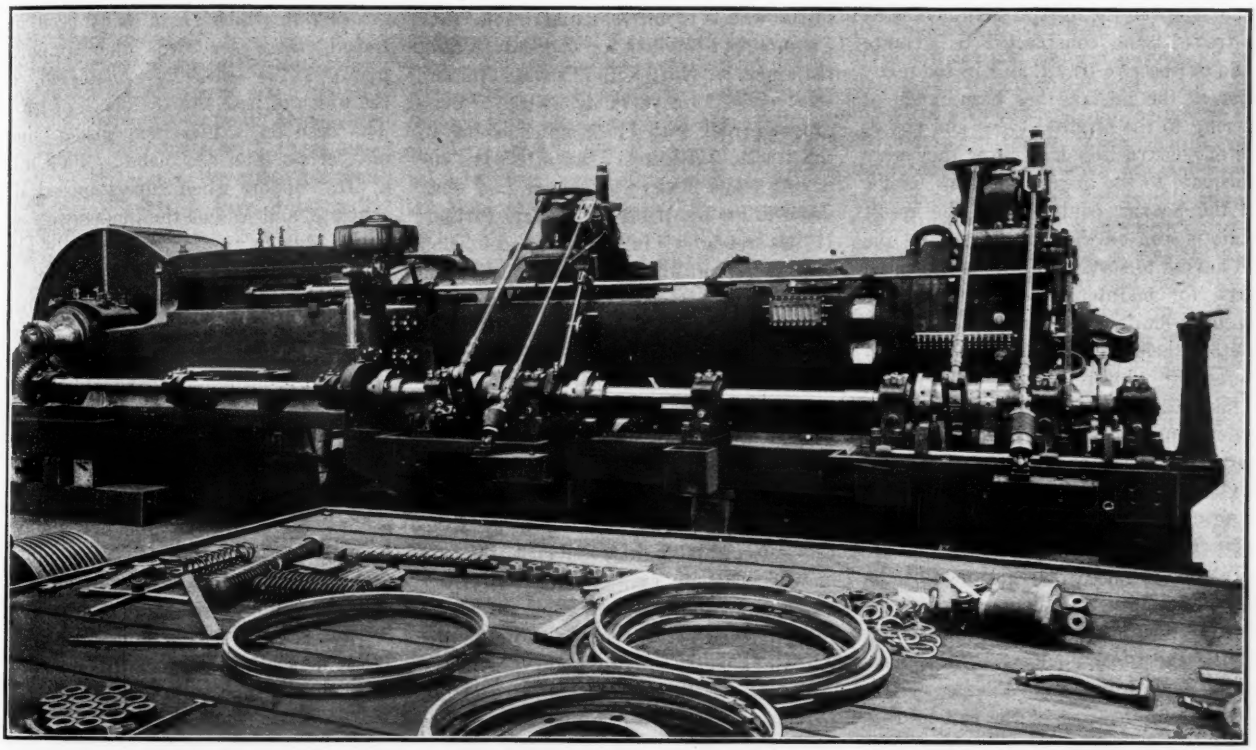


FIG. 4.—600-HORSE-POWER TANDEM BLAST FURNACE GAS ENGINE, DIRECT-CONNECTED TO ELECTRICAL GENERATOR.

TRACK CONSTRUCTION AND MAINTENANCE.[1]

BY T. W. WILSON.

The close relationship of the terms "construction" and "maintenance" does not seem to be fully appreciated. The track upon which all the traffic has to be carried is one of the most essential parts of a railway, and yet the importance of the track and track work in relation to the operation of the railway, and the portion which the maintenance of track bears to the total operating expenses do not seem to be fully recognized by street railway officials. This proportion is usually high and due to a great extent to the fact that the majority of our street railways were originally built by promoters with regard to immediate cheapness of construction. While this was justified in many cases by the tracks being constructed in advance of the prospective travel, still in too many instances the mistake has been made of adhering to the original types and standards of construction long after they were inadequate to the greatly increased traffic and the heavier equipment. The result of this is seen on the auditor's books, the road having to sustain an undue continual charge for maintenance. If those who originally built street railways had to maintain them they might have been built differently. This rebuilding of old track to take care of increased travel and heavier equipment makes necessary the construction account of which has been aptly said: "The construction account can never be closed until our railways are built. To attempt it involves a destruction account of fearful magnitude. Under our present system we are perpetually rebuilding our railways, not reaching the life of our works, and thus running capital to waste. A better system will strike at the root of the evil by correcting, not nursing, the defects of our permanent way."

It behooves us, therefore, to carefully review our standards of construction in order to be certain that we are building for the future.

On October 9, 1901, the Committee on Standards of the American Street Railway Association reported in favor of a tee rail for use in city streets whether paved or unpaved, their recommendation being: "We recommend a tee rail as the most desirable under any conditions."

This is the generally accepted solution of the rail question, the familiar arguments of the tee rail being small resistance to tractive force, ease of installation and the keeping of vehicular traffic away from the tracks. And yet it would seem that we lose sight of the most important point, *viz.*, the maintenance of the pavement along the gauge line side of rail. On "Archer avenue," in Chicago, a mile of Trilby girder rail and a mile of tee rail were laid side by side about two years ago in order to convince the municipal authorities that the tee rail was the best. The writer inspected this stretch of track lately and found that while the girder rail track was practically as good as new, the paving along the inside of the tee rail had been rutted out badly by the teams, in some places the ruts being four inches deep. That track looks as if it would have to be entirely repaved within a short time, and meanwhile is a constant menace to the wheels of all vehicular traffic, with a consequent liability for accident. Again, the track on North Main street, Buffalo, was relaid four years ago with a semi-groove girder with block stone paving in the tracks. Within a year afterward the paving stone next to the gauge had worn down to the lip of the rail but no further. It has remained in the same condition four years and will apparently outlive the rail. If this track had been built of tee rail, repaving would now be in order.

So it would seem that we can not afford to overlook the fact that the pavement along the tee rail is subjected to much greater wear than along the girder and may be a source of expensive maintenance on busy streets. As to the question of keeping the vehicular traffic away from the tracks, this might possibly be the case on wide, smoothly paved streets of cities of less than 200,000 population and where there is very little trucking. But in the narrow, busy thoroughfare of the larger cities, where there is not room enough in the street for the vehicular and car traffic, this would be impossible, and a rail must be installed which will provide for the trucking as well as for the cars, and afford the best protection to the paving adjacent to it.

These were the reasons which probably led up to the adoption of the "Crimmins" or "Trilby" shaped rail (so called on account of its resemblance to a foot when inverted), which has been laid in New York, Chicago, Washington, and many other cities, which finds its highest development to-day in a section weighing 137 pounds per yard, now being laid in Philadelphia. The extra weight of this rail has nearly all been placed in the lip, solely for the purpose of furnishing a runway for the tires of vehicles and keeping them off the pavement. Another argument against the tee rail is that nearly all the municipal authorities of our larger eastern cities, and the public, are against its adoption on account of the aforesaid ruttings, and the city ordinances usually prohibit it. As public carriers, we can scarcely afford to ignore their point of view.

A practical solution of the rail question would seem to be to use the nine-inch Trilby type in the busiest thoroughfares of our larger cities, where the trucking is heavy and the traffic congested; the semi-grooved girder in the quieter streets and those districts which by reason of architecture and location have become fixed as resident districts; and the tee rail in the smaller towns and cities, and in the suburbs of the large cities.

Besides the shape of the lip of the girder rail, which has already been mentioned, there are two other important points to be carefully considered, *viz.*, the width of base and the depth of groove. The base on a nine-inch girder should not be less than six inches. This makes a firm support when superimposed upon concrete, and lessens the tendency of wide gauge, due to tipping. Too little attention is paid to this point by street railway engineers. When the track and all its fillings are new a narrow base does not matter so much, but after eight or ten years of continuous service, with the pavement loosened and the ties rotten, the six-inch base should do its work well.

The depth of groove should not be less than one and one-quarter inches. With the use of a concrete roadbed the wear upon the head of the rail is undoubtedly greater than with a flexible roadbed, and every one-thirty-second of an inch of increased depth means a longer life for the track, depending of course upon depth of wheel flange and condition of traffic.

Very careful measurements in Buffalo have resulted in determining that the average wear of head for four years on the busiest street has been one-thirty-second inch per year. The largest tread operating over this track being three-quarter inch and the original depth of groove being one and one-quarter inches, a very simple computation gives sixteen years as the life of this track. In this connection it will appear strange to the old trackman to speak of the life of the rail being fixed by the wear of the head rather than the joint, but this is one of the results the welded joint has achieved. To be paradoxical, after the joint is welded it ceases to be a joint.

With the advent of the welded joints came a great decrease in maintenance. The

[1] Paper read at eleventh annual meeting of Street Railway Association of the State of New York, Syracuse, N. Y., October 6-7.

cost of welding of joints has been carried on for some eight years, especially in the West, with varying success. The percentage of breakage never seems to have been less than two and one-half. The electric weld we are all familiar with and it seems to be the highest type of joint to-day. The per cent of breaks during the last year has been kept down to the astonishing figure of one-tenth of one per cent. The only objection to this joint is in its method of application, a train of four cars being necessary which occupies the track and interferes with the regular traffic. Another drawback is, that it is not possible to contract for a small number of joints on account of expense attached to shipping the equipment from place to place. This puts it beyond the reach of all roads that have less than 2,000 joints to weld.

Among the best of the mechanical joints is the riveted splice bars of the Philadelphia Rapid Transit Company. It consists of the regular splice bar, with rivets substituted for bolts, and the space between the rail and the bar is filled solid with molten zinc.

With the introduction of concrete roadbed came the necessity for a steel tie, as with a track whose life is estimated at from fifteen to twenty years, it would hardly be economy to install ties with a life of from ten to twelve years. These steel ties should be secured to the rail by means of brackets which fit up well under the head of the rail, and which accomplish the same purpose as a brace tie plate or a tie rod. Old rail can be very readily used as a tie when cut up into proper lengths.

Where wood ties are used on interurban work, they should be white, rock or burr oak, or long leaf southern pine. Cedar, while being long-lived, is too soft, especially with heavy interurban passenger and freight service, and will not nold a spike.

While on the question of ties, it may be of interest to note that the steam and electric railways of the United States are using over one hundred million wood cross-ties per annum. The prices are constantly advancing and it is evident that we will be forced to turn to the steel tie as a substitute for wood. As a starter, the entire roadbed of the Pittsburg, Bessemer & Lake Erie Railroad is being equipped with steel ties.

One of the greatest, if not the greatest source of expense for track maintenance is on account of no ballast, loose track, and consequent failure of pavement. Miles upon miles of track in which the rail was good, the joint perfect, and the tie sound, have been torn up and relaid because the ties had been laid in the mud, concrete placed on top of them and around them, in fact any place but underneath them, and the whole surmounted by a three-inch veneering of asphalt laid right against the rail. Could anything be more criminal? Such a track will last from three to six years, depending upon traffic, and then suddenly the pavement will go all to pieces.

"Never lay asphalt against a steel rail" has come to be a street railway axiom.

Brick, sandstone, granite, all make a very acceptable pavement, but in order to preserve the pavement it is necessary to have a foundation of concrete, and this means concrete under the rail and ties.

The concrete roadbed consequently, either of the beam or solid type, has come to be a recognized standard, and although some objection is made to this construction on account of the rigidity of the track and the wearing of the rail, yet a railroad can better afford to have the head of the rail wear for a certain period for no maintenance, than to have it wear a little longer time with constant repairs to pavement.

Owing to different prices of material at various places, estimates of cost must necessarily vary with the locality. The following may be of interest, however:

CONSTRUCTION.

1. Replacing old six-inch track in asphalt pavement with new nine-inch ninety-four-pound girder rail, Portland cement, concrete base, steel ties at ten-foot, welded joints, No. 1 Medina sandstone block paving with grouted joints, toothing and asphalt in two-foot strip, including cleaning up street, and allowing salvage on old six-inch rail. Per foot of single track, about $4.30.

2. Relaying and welding rail already in street, concrete base, steel ties, pavement, etc., as above, except that there is no salvage. Per foot of single track, $3.30.

The cost of maintenance of track and roadway of nine railways, per mile of single track, per year, for 1901, is given in table below. It will be seen that the cost varies from $215 to $733 per mile. It is interesting to note that the larger the mileage the higher the cost of maintenance seems to be. Not much can be gleaned, however, from these comparative figures as the conditions are so diverse; for instance, the Brooklyn Heights is mostly on elevated structure and of course is more costly to maintain. The cost per car mile of maintenance of track and roadway for International Railway Company for 1903 was 0.008.

COST OF MAINTENANCE PER MILE OF SINGLE TRACK FOR YEAR 1901.

Railway Company.	Mileage.	Tracks and Roadway.	Remarks.
B'klyn Heights R. R. Co..	401	$733	6 mo. end. Dec. 31
Cleveland Elec. R. R. Co..	....	630	All city
Montreal Street Ry.....	103	469	All city
Rochester Ry. Co.....	100	378	City and sub.
Denver City Tramway....	144	298	All city
International Ry., 1901....	330	290	City and sub.
International Ry., 1903....	457	258	City and sub.
Milwaukee, 1900.....	225	250	City and sub.
Scranton Ry. Co.....	76	321	City only
Schenectady Ry.....	32	215	City and sub.

As potent a factor as any in the economical construction and maintenance of track is the organization not alone of the track department, but of every individual job undertaken. All work should be carefully laid out and planned beforehand and the plans rigidly followed. As little initiative as possible should be left to the subforeman. Cheap tools, cheap material and cheap foreman are not necessarily economical, and are usually the reverse. And above all, a close watch must be kept on details, with a view to turn aside all the undirected and misdirected tendencies which might lead to extravagance, inefficiency, or whatever in the end might operate depressingly upon dividends, which after all constitute the ultimate aim of our friends the directors.

Fire Protection at the St. Louis World's Fair.

The authorities of the Louisiana Purchase Exposition are making adequate provision for water supply by putting in one of the largest installations of fire pumps in the world. The exposition authorities are doing everything possible to prevent a recurrence at St. Louis of any disastrous conflagration such as has marked previous expositions in other parts of the country. These pumps have been purchased from Henry R. Worthington Company, New York city, and comprise twelve 1,000-gallon standard "Underwriter" fire pumps, each capable of supplying four fire streams, making it possible to have forty-eight fire streams in operation at one time. The pumps are of the duplex double-acting type, and are supplied with air and vacuum chambers of large capacity. The fittings are of composition metal, and the piston and valve rods are of bronze. Every measure has been taken in designing these pumps to ensure their starting at a moment's notice at any time after having been idle for a long period.

THE CONDITIONS GOVERNING THE RISE OF TEMPERATURE OF ELECTRIC RAILWAY MOTORS IN SERVICE.[1]

BY CARY T. HUTCHINSON.

In a former paper read before the Institute (Transactions of the American Institute of Electrical Engineers, vol. xix, p. 129), I described a method for determining the motor capacity and energy required to make any schedule speed for a run of any distance, with electric motors. Since that time I have extended the method to include the predetermination of the rise of temperature of the motor when those constants of the motor are known, upon which the rise of temperature depends.

In that investigation the time required for each of the three periods of the "type-run," shown in Fig. 1, was first determined; this was an algebraical problem, the solution of which involved the initial acceleration (a), the coasting retardation (b), the retardation after braking (c), the length of the run and the average speed from start to stop. These equations are:

$$x/T = A_0/a - K_1 (A_0 - A)^{\frac{1}{2}}$$
$$y/T = K_2 (A_0 - A)^{\frac{1}{2}}$$
$$z/T = 2\ A_0/c\ K_3 (A_0 - A)^{\frac{1}{2}}$$

in which K_1, K_2, K_3, and A_0 are simple functions of (a), (b) *and* (c) only; x, y and z are respectively the times of initial acceleration, coasting and braking, and T the total time, as shown in Fig. 1. The only quantity occurring in these equations other than the three accelerations, (a), (b) and (c), then, is

$$A = V/T = 0.682\ L/T^2$$

T being the time and V the average speed from start to stop; the form of the equation shows that all runs having the same values of (a), (b), (c) and A will be made in the same proportionate time for the different periods, *i. e.*, the same fraction of the total time will be required for accelerating, coasting and braking. In other words, all runs having the same value of the accelerations and of $A = V/T$ are represented by the same figure, with merely a change in scale for the different lengths of run, the ordinates and abscissæ being proportional to $L^{\frac{1}{2}}$.

This quantity A reduces the variables from three—V, L and T—to two—A and L. A is a convenient quantity to use as independent variable for the curve-sheets; it simplifies the presentation, since all runs having the same values of A, (a), (b) and (c) require the same energy per ton-mile, independent of the length of run or the average velocity, and require a motor capacity directly proportional to the square root of the length of run—that is, directly proportional to the time from start to stop.

Moreover, all values of A occurring in practice can be included between the values of 0.15 and 0.35—a relatively small variation, whereas variations in V, L and T cover a much wider range.

It is to be remembered that the previous investigation, as well as this one, assumes a straight, level track, constant train friction and constant braking force. These assumptions are necessary to any general treatment, since curvature and gradients are arbitrary. I have, however, in part, developed a method for making the necessary allowances for curves, grades and variable train friction in the form of corrections to the values found for the corresponding simple case.

These equations involve four quantities, of which, two—(b) and (c)—are assumed to be constants and two—(a) and A—the variables. The solution of the equations is best given by curve-sheets, with x/T, y/T and z/T as ordinates, and A as abscissæ; a separate curve is required for each value (a). Curve-sheet 1 is plotted with

(b) = 0.15 mph/sec. = 13.6 lbs. per ton and

(c) = 2 mph/sec. = 182 lbs. per ton; (c) is the total retardation after braking, including train friction. This curve-sheet is similar to curve-sheet 2 of the first paper, save that there the values, (b) = 0.2 and (c) = 3 mph/sec., were used.

Fig. 1 shows the type case, with three constant accelerations; Fig. 2 the actual case, in which acceleration on the motor curve is added to the constant initial acceleration; Fig. 2 then involves the characteristics of the motor used. Curve-sheet 5 of the first paper gave the average speed and torque curves of a number of tramway motors in common use; I have since added other motor curves, and in curve-sheet 2 show average motor curves, which represent with practical accuracy the torque and speed relations of any General Electric or Westinghouse motor, throughout the range of ordinary operation. The extreme difference between the speed of any motor of either company and the speed on this curve-sheet for a given torque is greatest at the high speeds, but within the range of ordinary operation this variation is less than five per cent.

It is necessary to assume the same motor performance in order that the variation in energy consumption and motor capacity required by the different schedules when made with various initial and motor accelerations may be shown independently of variations in characteristics of the motor. If one assumes other motor curves, the methods outlined here can be applied by making certain corrections; but, as a matter of fact, the small variations in the shape of the motor curve are of comparatively slight consequence in the final results.

The efficiency of different motors varies through a much wider range than do the speed and torque; but the efficiency is used only in connecting the input and output, and not in determining heat losses, which are the subject of a separate consideration; hence considerable differences in efficiency curves are of minor consequence.

Here, as in the first paper, the datum points for these motor curves is the load determined by the "hour rating"—that is, the load the motor will carry for one hour with a temperature rise of seventy-five degrees centigrade when tested on the stand, with covers off; this value is assumed to be the commutation limit of the motor capacity and all the results of the investigation are expressed in terms of the input donated by the datum point; therefore it only remains to determine the conditions of a run which will give the limiting temperature elevation when the motor is used at this particular input. The hour rating for the maximum input is not unduly conservative, it leaves a margin for greater power on curves, grades and for emergencies.

Curve-sheet 3 and curve-sheet 4 give energy and motor capacity in terms of through acceleration A; they are the same as curve-sheet 13 and curve-sheet 14 on the first paper, except that here the abscissæ are through acceleration with the motor curve instead of the corresponding through acceleration with the type curve; that is, the quantity A_m of the first paper is used as abscissa instead of the A of that paper, but is designated A; and that the motor capacity is given for a run of one mile. This change simplifies the use of the curves, in that it makes it unnecessary to add corrections to the value of A calculated from the data given for the run. Curve-sheet 3 then gives directly the energy per ton-mile for any run and for initial accelerations from 0.6 to 3 mph/sec., and for a train friction of 13.6 pounds per ton, equivalent to (b) = 0.15, a retardation after braking equivalent to two mph/sec., and all for an acceleration on the motor curve to a speed

[1] A paper presented at the 180th meeting of the American Institute of Electrical Engineers, New York, October 23, 1903.

fifty per cent greater than the speed with all resistance out.

Curve-sheet 4 gives the horse-power per ton for the same conditions; in the first paper, motor capacity was given in kilowatt input; here it is reduced to horse-power output. These curves give the motor capacity per ton required for any run expressed in terms of the maximum

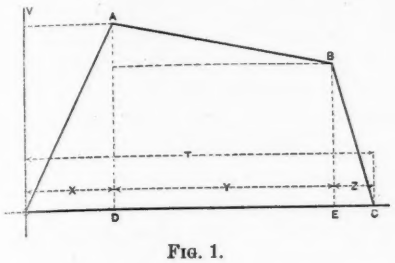


FIG. 1.

power input at the end of the initial acceleration.

An example will best explain their use: suppose

Schedule speed = 30 mph.
Distance = 7,000 feet.
Time of stop = 25 secs.

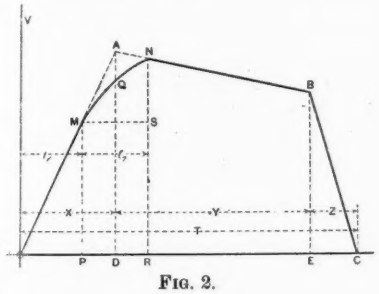


FIG. 2.

Then

Time from start to start = 159 secs.
" " " " stop — T = 134 "

Average velocity = 30×159/134 = 35.6 mph.

Through acceleration, A = 35.6/134 = 0.266.

Suppose further that the speed, energy

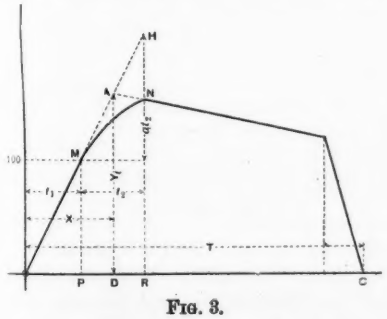


FIG. 3.

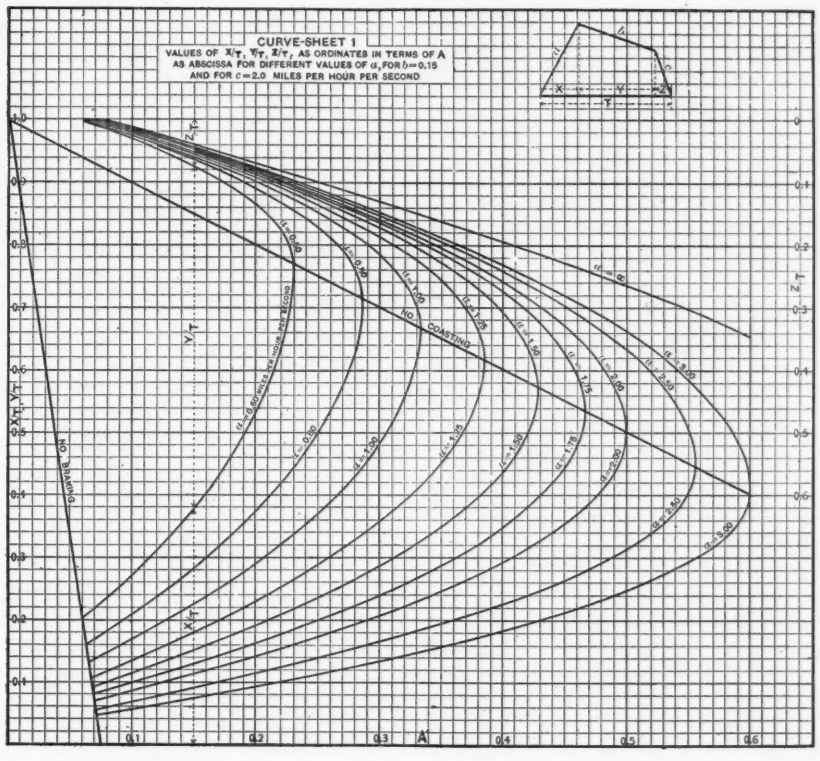
and motor capacity are to be determined for

(a) = 1.25 mph/sec.,

and a velocity on the motor curve of 150. Then,

Relative maximum velocity on type curve = 160 (curve-sheet 5).

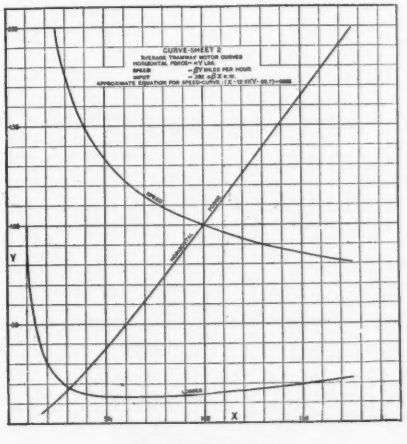
(Curve-sheet 5 is plotted from the velocity time curves for the various initial accelerations.)


CURVE-SHEET 1
VALUES OF X/T, Y/T, Z/T, AS ORDINATES IN TERMS OF A AS ABSCISSA FOR DIFFERENT VALUES OF a, FOR f=0.15 AND FOR c=2.0 MILES PER HOUR PER SECOND
NO BRAKING
NO COASTING
Z/T
Y/T
X/T
A

CURVE-SHEET 1.

$x/T = 0.306$ (curve-sheet 1)
Hence, $ax/T = 0.306 \times 1.25 = 0.382$
and $ax = 0.382 \times 134 = 51.2$ mph.

This is the maximum velocity on the type curve.



CURVE-SHEET 2.

Hence,

Maximum velocity on motor curve = 150/160×51.2 = 48 mph.

and

Velocity at resistance out = 100/150×48 = 32 mph.

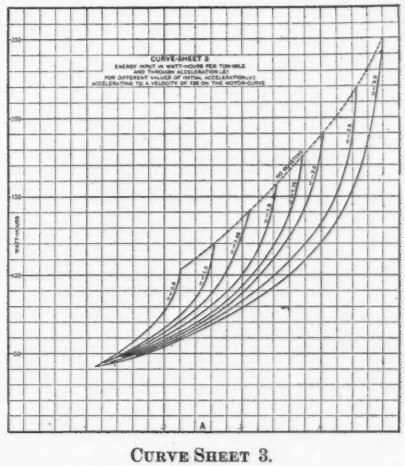
hence,

Velocity coefficient = 0.32

(Velocities are uniformly expressed in terms of the velocity at maximum power, as 100; the actual velocities are then equal to β 100, where β is a coefficient determined as indicated here, or in the manner explained in the first paper.)

Time of initial acceleration = 32/1.25 = 25.6 secs.

Usually it will not be necessary to de-



CURVE SHEET 3.

termine the times required by the various parts of the run, but this can be done as follows:

$x/T = 0.306$	(curve-sheet 1)
$y/T = 0.545$	(curve-sheet 1)
$z/T = 0.149$	(curve-sheet 1)
1.000	

Hence

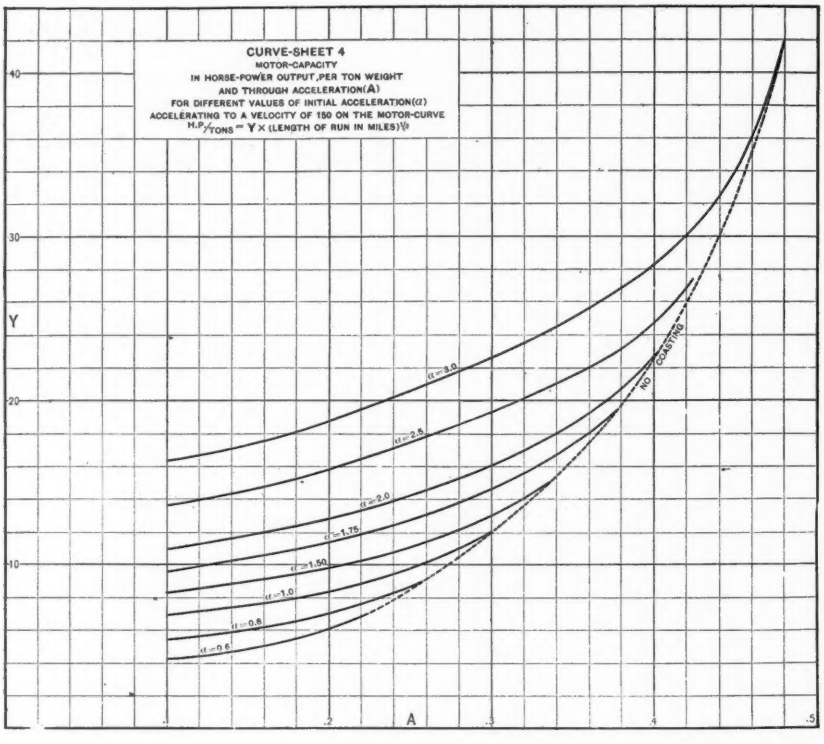
x/T = 41 secs.
y/T = 73 "
z/T = 20 "
T = 134 secs.

Referring to Fig. 2:

Time of initial acceleration (OP) = 25.6 secs.

Time of acceleration on motor curve (PR) = $\beta \times 112 = 0.32 \times 112$ (curve-sheet 6) = 35.8 secs.

(Curve-sheet 6 is taken from the separate velocity time curves.)



CURVE-SHEET 4.

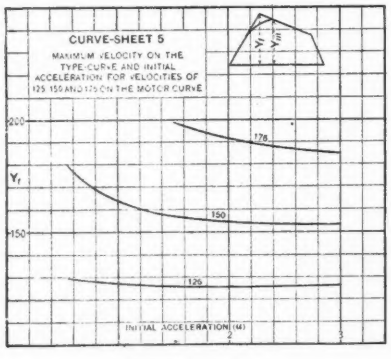
Time of total acceleration (OR) = 61.4 secs.

Time of total acceleration on type run (OD) = 41 secs.

Difference (DR) = 20.4 secs.

Time coasting on type run (DE) = 73 secs.

Difference, time coasting on motor-run (RE) = 52.6 secs.



CURVE-SHEET 5.

The various times are then,

Initial acceleration	(OP)	= 25.6 secs.
Motor acceleration	(PR)	= 35.8 "
Coasting	(RE)	= 52.6 "
Braking	(EC)	= 20 "
Total	(OC)	= 134.0 secs.

It is noteworthy that this total, made up from readings taken directly or indirectly from half a dozen curve-sheets, should check exactly; of course such accuracy is partly accidental, but it shows how well graphical work of this character can be done.

The distance passed over for the various portions of the run can be calculated in a similar manner from other curve-sheets which are not given here.

Further, from curve-sheet 4.

$$\text{Motor capacity} = 10.8 \left(\frac{7{,}000}{5{,}280}\right)^{\frac{1}{2}} =$$

12.5 hp/ton.

Energy per ton-mile = 92 wh (curve-sheet 3).

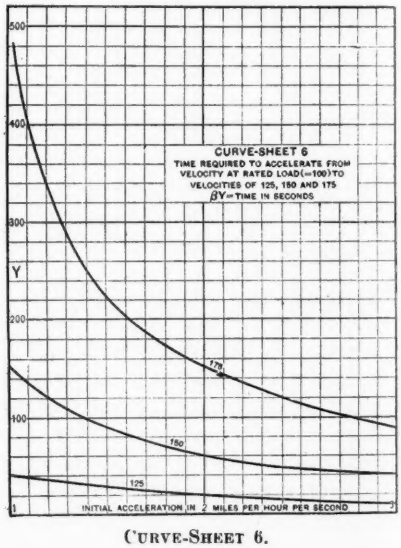
The results of the assumption of any other initial acceleration are obtained in the same manner.

These calculations show that the energy consumption and motor capacity can be determined when the "through acceleration," the initial acceleration and the amount of use of the motor curve are given. As I show below, the initial and motor accelerations are fixed by considerations of heating; hence the conditions are entirely determinate.

The input and output of the motor when accelerating to any maximum velocity at any rate can both be obtained by integrating the appropriate power and velocity curves. A comparison of these figures shows that the efficiency for constant maximum velocity is practically independent of the initial acceleration. Both the input and output vary, but their ratio varies slightly; for instance, for a maximum velocity of 125, the input of the motor varies from 804 to 653 wh when the initial acceleration is varied from 0.6 to 3 mph/sec.; for the same range the output varies from 517 to 415; hence the efficiency then varies only from 64.3 to 63.5 per cent, a total variation of only 0.8 per cent for a variation from 0.6 to 3 mph/sec. in the initial acceleration. Sixty-four per cent may be considered the efficiency for a maximum velocity of 125, regardless of the initial acceleration. This is for the motor shown on curve-sheet 2, of which the efficiency at rated load is eighty-five per cent. For a maximum velocity of 175, the efficiency varies from seventy-one to seventy-three per cent.

Curve-sheet 7 gives the efficiency of this motor equipment in terms of the maximum velocity. The values of efficiency from this curve-sheet can be used with small error to determine the input from the output.

A deduction from the fact that the efficiency is independent of the initial acceleration is that the average heat loss is independent of the initial acceleration, which is also deduced directly. It is true that in the losses, friction loss is included, but the average friction loss from zero to a fixed maximum velocity will not vary with the initial acceleration; hence the difference, representing the heat loss, must be constant to the same degree of approximation that the efficiency is constant.



CURVE-SHEET 6.

The formula following gives the work done at the car axle per ton-mile for various schedules, in terms of the through acceleration and the proportional part of the total time used in braking. This for-

mula and the efficiency from curve-sheet 7 permit the easy determination of the energy input per ton-mile.

The formula for work per ton at the car axle is deduced by calculating the work of friction for the entire distance, and the kinetic energy at braking; by the substitution of

$$L = 0.682\ AT^2$$

the through acceleration is included, and hence the schedule. The formula is:

Work per ton-mile at car axle $= 180\,b + 90\left(c - b\right)\frac{c}{A}\left(\frac{z}{T}\right)^2$ wh

The first term, 180 b, gives the work of friction per ton-mile; the other term, the energy wasted in brakes per ton-mile. z/T is a function of the three accelerations, (a), (b) and (c), as well as of the through acceleration. Hence the values of z/T to be used in this formula must be obtained from curve-sheets plotted for the particular values of (b) and (c) that are substituted in the formula. Curve-sheet 1 is calculated for $(b) = 0.15$ and $(c) = 2$. Substituting these values in the above formula, it becomes,

$$\text{Work} = 27 + 333/A \times \left(\frac{z}{T}\right)^2 \text{ wh}$$

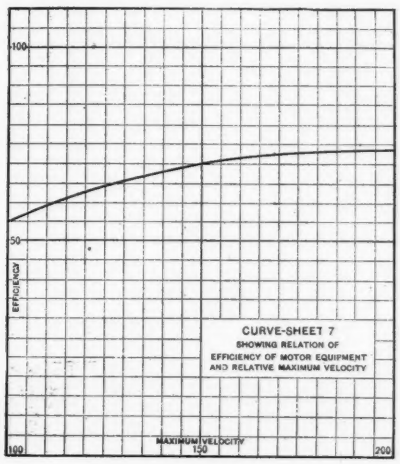
To apply this formula, find first the value of the through acceleration on the type curve corresponding to the through acceleration A on the motor curve, given by the data of the problem. Curve-sheet 8 gives this relation for a maximum velocity of 150. Having this value of A^1, the through acceleration of the type curve, select from curve-sheet 1 the value of z/T corresponding to that value of A^1 and of the initial acceleration in question. For example,

For A = 0.266
and velocity = 1.0

Curve-sheet 8 shows that A^1 equals 0.275. The value of z/T for this value of A^1 and for an acceleration of 1.5 mph/sec., from curve-sheet 1 is 0.15, substituting in the above formula the work per ton-mile at the car axle is found to be equal to fifty-six wh; the efficiency, from curve-sheet 7 is seventy per cent; hence the energy input is eighty wh. Curve-sheet 3 shows for the same conditions; *i. e.*, for $A = 0.266$ and $(a) = 1.5$, an energy input equal to eighty-three wh, an agreement sufficiently close.

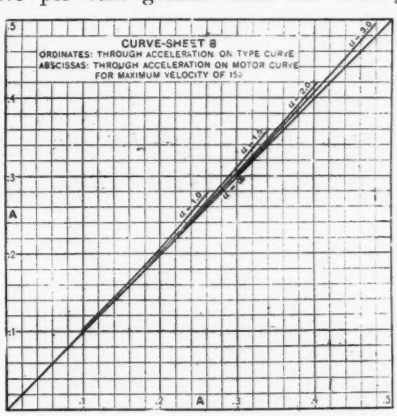
In the first paper, I assumed that an electric tramway motor in service will carry, on an average, a heat loss of three per cent of its "hour-load," with a temperature elevation of seventy-five degrees centigrade. This is a fair average figure, but individual motors differ greatly in their heating characteristics; hence I have elaborated the method so that it may be used for motors having any copper loss and any core loss, for any schedule with any initial acceleration.

For this purpose I determine the ratio of average loss to loss at rated load for the copper and core loss separately, and for the several initial accelerations; knowing then the ratio of average loss during



CURVE-SHEET 7.

acceleration to loss at rapid load, the average loss for any particular motor is found by multiplying the proper value of this ratio by the loss at rated load, separately for copper and core loss; the results added will give the total average loss during acceleration. These ratios of average to maximum loss were determined for velocities of 125, 150 and 175 on the motor-curve; that is, for maximum velocities twenty-five, fifty and seventy-five per cent greater than the velocity



CURVE-SHEET 8.

with resistance out. In describing this method further, it is to be understood that this procedure was followed in all cases; in other words, three separate sets of curves were carried through for the three maximum velocities, for the heat losses, for ratio of distribution, for motor capacity, for energy curves, and for the various other intermediate curves which were used as steps to the final results.

The rise of temperature of the parts of a motor, as determined by tests, depends upon the ratio of the distribution of the total heat loss between the armature and field; to apply such test results correctly this ratio must then be known for the various conditions; hence the ratio of distribution was calculated for the several initial accelerations and maximum velocities; the average loss during acceleration and its distribution having been determined in this manner, the average loss during the run will be known when the ratio of time of acceleration to time of run, for the various initial accelerations, maximum velocities and for all values of the through acceleration is known.

Having then the average loss during the run and its distribution between armature and field, the rise of temperature of a motor, used under the conditions of service fixed by any particular ratio of distribution, can be determined by comparing this calculated average loss with the rise of temperature per watt lost, for the same ratio of distribution, as determined by tests in service.

These steps required the preparation of nearly a hundred curve-sheets and some four hundred curves—the matter is too voluminous to present here in detail; I shall therefore give only the results and call attention to a few of the principal steps.

The ratio of average to maximum copper loss is definite and was determined in the usual manner by plotting values for the current and integrating.

(To be continued.)

American Institute Electrical Engineers.

ASSOCIATES ELECTED AT DIRECTORS' MEETING, NEW YORK, FRIDAY, OCTOBER 23, 1903.

Roy Harmon Adams, New Orleans, La.
Paul Lewis Anderson, East Orange, N. J.
Charles Fowler Baldwin, Antwerp, Belgium.
E. G. C. Barton, Brisbane, Queensland.
Elmer E. Beam, Ashtabula, Ohio.
Leon Beauchamp, Montreal, Quebec.
Ralph Bennett, Los Angeles, Cal.
James Dillon Brooke, New York city.
A. J. Byington, Santos, Brazil, South America.
William G. Chace, St. Catharines, Ontario.
Frank Ross Chambers, Jr., Seattle, Wash.
George Percy Cole, St. Louis, Mo.
J. H. Davies, Johannesburg, South Africa.
Ferdinand John Foote, Norwood, Ohio.
Hugo Fuchs, Chicago, Ill.
George Adam Fuchs, Erie, Pa.
Louis Brounell Hastings, Pittsfield, Mass.
Clarence Freer Hill, Philadelphia, Pa.
William Levi Hoffman, Wilkinsburg, Pa.
Samuel Huston, Kaukanhalli, Mysore State, India.
Gustav Adolf Juhlin, Preston, England.
Gaylord B. Kirker, Le Havre, France.
George Spangler Loutey, Philadelphia, Pa.
Irving Loveridge, Antwerp, Belgium.
Newitt Jackson Neall, Edgewood Park, Pa.
Will Harold Oldham, Johnstown, Pa.
Coleman Clyde Parks, Munhall, Pa.
Frederick Welles Prince, Hartford, Ct.
Yasuo Riko, Tokyo, Japan.
Robert Sibley, Berkeley, Cal.
Thomas O'C. Sloane, South Orange, N. J.
Worrall E. S. Temple, Pocahontas, Va.
Radley Mott Trille, Cienfuegos, Cuba.
F. T. Wright, Kensington, London, England.

TRANSFERRED FROM ASSOCIATE TO THE GRADE OF MEMBER.

William Howard Cole, Singapore.
Walter Atwood Hall, Lynn, Mass.
William Weedon Cole, Elmira, N. Y.
Walter I. Slichter, Schenectady, N. Y.

The Administration Buildings at the St. Louis Exposition.

FROM its inception, the plans of the St. Louis Exposition have grown greater, the funds augmented and of necessity the area has been increased from time to time. When the Forest Park grant was found inadequate, the exposition turned to Washington University and secured a lease of the new campus. This tract has a frontage of 1,600 feet on the west side of Forest Park and contains 110 acres. A few of the buildings were completed and others in the process of erection, making eleven in all. The university buildings are of uniform Tudor-Gothic architecture and built of pink granite at a cost of $1,300,000. A complete system of lighting, ventilation and heating was installed so that in every way the buildings are adapted to the needs of the exposition. So complete were these facilities for housing the officials and carrying on the administrative business of the exposition that it has been a great help in expediting the work up to date.

The structure which is shown in the foreground became the Administration Building, and contains the offices of the president, director of exhibits, chief of the department of electricity and other officials. The building embraces fifty rooms and cost $225,000.

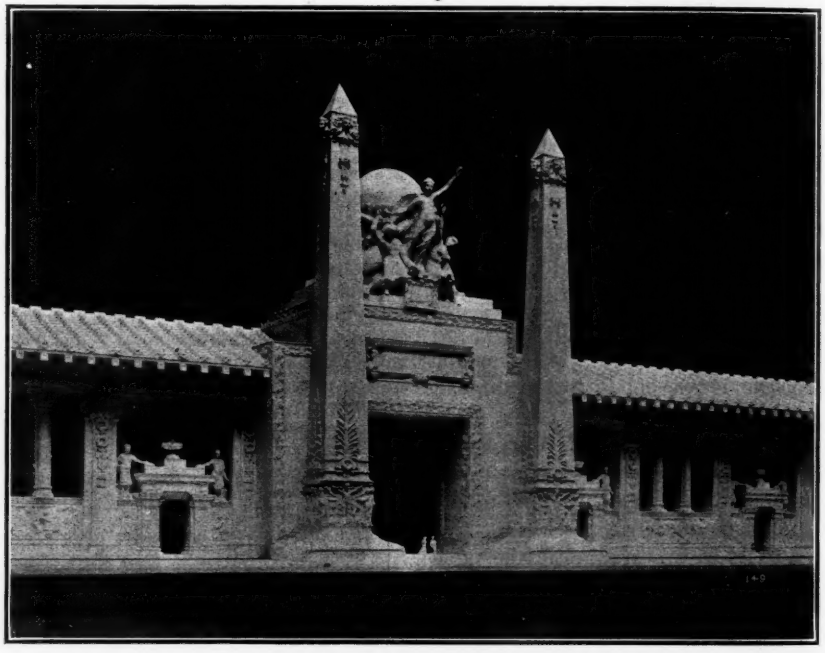
Perhaps the most beautiful building is the university library, which is to be the hall of international congresses during the exposition. It is situated directly west of the Administration Building and has a length of 257 feet and a depth of forty-six feet. There is also a structure in the rear of the centre of the library 110 feet long by forty-one feet wide. Four large assembly halls are available in the group, three 110 feet by forty-six feet, the fourth 100 feet by forty feet. The largest sections of the congresses will be held in this building. The smaller sections will be in the assembly and lecture halls and other buildings surrounding the quadrangle. In the library the international electrical congress will be held from September 12 to 17, 1904. From the interest already manifested the accommodations will be taxed to the utmost to take care of the foreign engineers of prominence who are expecting to visit the exposition at that time.

Cupples Hall No. 1, a structure 263 feet by 113 feet, erected at a cost of $150,000, will be occupied by the department of anthropology and ethnology. The south side of the quadrangle is formed by Cupples Hall No. 2, similar in form and dimensions to No. 1. This building is now occupied by the division of works.

West of the first quadrangle is the Physics Building, a granite structure, 178 by 69 feet and two stories high. Two projecting bays located at equal distances from the ends of the building surmounted by ornamental gables contain the entrances. This building is now being used by the board of lady managers. At the extreme west end of the campus is the gymnasium, 182 feet by ninety-four feet, erected at a cost of $150,000. Adjoining the gymnasium is the athletic field, 760 feet long, which will contain one of the finest tracks in the world, and an arena with a seating capacity of 25,000. Here the Olympian games will be held. These facilities will be available for the department of physical culture during the fair.

The other buildings are occupied as dormatories by the Jefferson Guards who police the grounds and buildings. On the extreme north side of the campus is the power-house, which contains seven 150-horse-power Wangler boilers supplying steam for power and heating. Three 150-horse-power, two-phase, 550-volt generators furnish current for light and motor power about the premises. From the power-house extend tunnels containing steam, water and electric mains running to the principal buildings. The main tunnel is six by eight feet in cross-section and 1,182 feet in length, from which run two branch tunnels, one 106 feet and the other seventy feet long.

Beauty, utility, comfort and convenience have been combined in the construction of these buildings, and when they are all completed Washington University will be as well housed as any college in the country. Both the exposition and the university have been mutually favored by this lease; the exposition by the splendid facilities already prepared, and the university by the addition of several hundred thousand dollars to its building fund.



DETAILS OF ENTRANCE. MINES AND METALLURGY BUILDING.

The Mines and Metallurgy Building at the Lousiana Purchase Exposition is unique in that from an architectural standpoint it is not approached by any of the other exhibition palaces. In fact, it has been spoken of by Mr. T. C. Link, architect of the building, as a type of "secession architecture," meaning by this a breaking away from conventionality in design, making the architecture of the building feelingly express the use for which it was built, rather than a construction along conventional lines and formulæ. The outside dimensions, 525 feet by 750 feet, confine an area considerable in excess of that provided by any other exposition for similar exhibits, and the arrangement of glass-covered arcades is such that the eight

rectangular divisions of exhibit area are equally well lighted.

A striking feature of the building is the ornate façade surrounding it on all sides which will constitute one of the most attractive bits of sculpture on the grounds. This façade consists of great sculptured panels illustrating in bold relief mining and metallurgical operations in symbolical representations, the background being of a rough golden-colored glass. At night these panels will be illuminated from behind, causing the figures to stand out prominently. Above these panels ornate columns rise supporting the cornice. The main entrance is flanked by two gigantic obelisks, 150 feet high, and above each of the four major entrances rises a great sphere of gold.

The low pitch of the roof and the use of monster tiles add strength to the architectural scheme and create an impression of stability.

In the department of mines and metallurgy the particular feature that is being incorporated in the exhibits is the exhaustive display of processes and products. Raw materials, with forms of metallic ores, clays, coals, building stone, etc., will as usual have a conspicuous space, but the elaboration and exploitation of mining and metallurgical methods showing the means of producing the finished materials will be emphasized in a large degree. The following display might be mentioned as illustrating this feature of the exhibits:

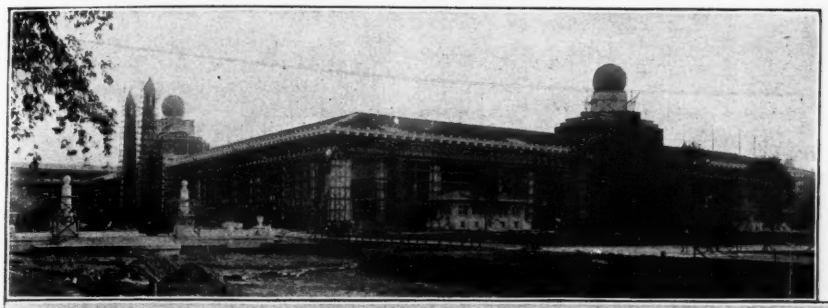
Operating exhibits of artesian and oil drills with the methods of using same, conducted on the open space southeast of the mines building. Here will also be located working mines and shafts, tunnels, etc., supplied with both electric and steam hoist operated so as to show the more modern methods of wire and rope transmission. These mines will have the advantage of operating on some of the well-known clay and coal strata underlying the exposition grounds and annexed territory, and the products will be conveyed by transmitters to tile and brick presses and there worked up into commercial forms by the most improved methods.

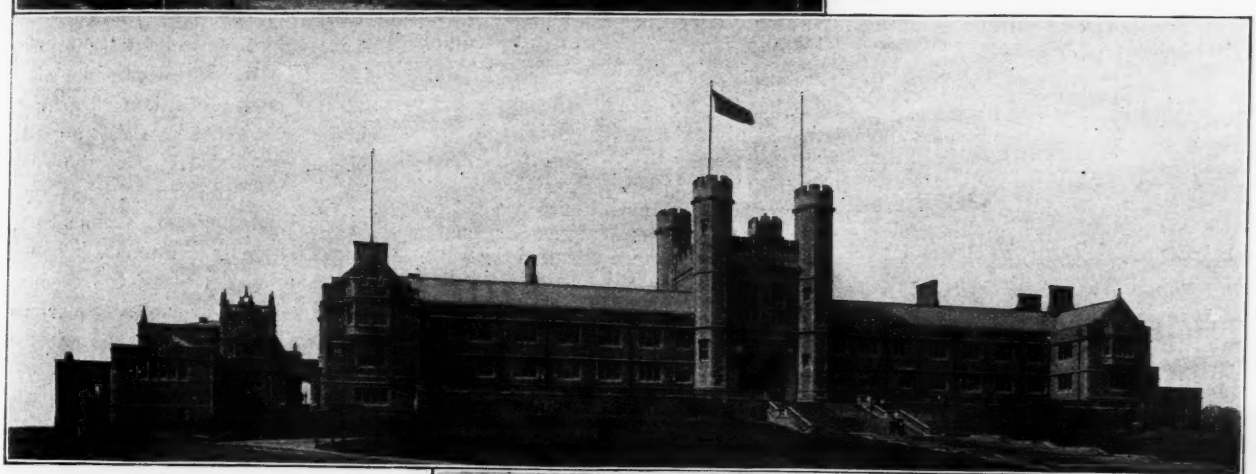
On this space will also be shown a full sized operating mill especially designed to crush and concentrate Missouri lead and zinc ores. This will be constructed with special reference to handling gold, silver and lead ores, such as constitute the more important mineral wealth of Colorado, Utah, California and the Rocky Mountain and Pacific Coast areas.

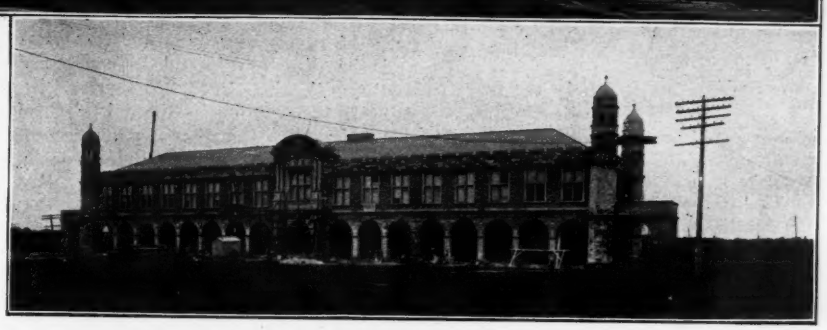
In order to meet the more popular demand there will be installed in contrast to the improved mills, ancient forms of the arastras and other primitive metallurgical devices. In this connection, after the metal has been extracted it will be made up by natives into the shapes utilized so long in their household economies.

In the main building covering an area of more than nine acres, under one roof, will be collected the best and most valuable natural mineral resources, together with many mechanical appliances designed for their utilization. These will include mills, rolls, crushers and concentrators of many designs and air and electric drills. Here also special care has been given to meet the full demands of the official classification and to display the best and most important in modern mining and metallurgical research.

Another special feature of the indoor display is the grouping of collective exhibits. Each of the states and foreign







1.—Mines and Metallurgy Building, St. Louis Exposition.
2.—Administration Building.
3.—Hall of Congresses.

countries will display under its own control and direction what is best of its minerals, but there will also be collective exhibits in the following classification: clay and clay products; coal in many varieties with exhaustive analyses; iron ores and finished products with numerous forms of steel, with descriptive maps and models; petroleum and mineral oils, precious stones with the cut and polished gems, and the more recently discovered metals, with a specimen of radium and its compound.

In the foreign department such countries as France, Germany, Russia, Great Britain, Japan and China and the smaller principalities and republics have all applied for and have been granted liberal space, with the assurance that no effort will be spared to make their exhibits worthy of the opportunity offered.

The more technical and educational features will be represented by a fully equipped assay office, conducted by students and experts, and a fully equipped technical and scientific library, geological maps, charts, models, etc. Several states and nations have also promised to install in their exhibits certain special distinctive objects more likely to attract popular favor, such as gold and quartz, copper ores, telluride, etc.

High-Speed Railway Trials.

The original track laid down for the Marienfeld-Zossen experimental railway did not seem safe for speeds exceeding 160 kilometres per hour, because at those speeds the cars ran very joltingly, the rail showed signs of bending, and cracks were observed in the iron sleepers. The new rails since put down for the recent tests weigh forty-one kilogrammes per metre and were laid in lengths of twelve metres, the support being by means of eighteen sleepers of pine wood per length of rail. Broken basalt was employed as a ballast. As a preventative measure against derailment, a guide rail was laid along each rail, the slot being fifty millimetres wide; but so far these rails do not seem to have come into actual use. It is said that the cars now run as quietly at 200 kilometres per hour as formerly at from 130 to 140 kilometres per hour, and that it is possible for the passengers to write notes when either standing or sitting in the moving car, at its highest speeds. The primary voltage during the successful runs was 14,000 volts. Trouble had been experienced previously from vibration of the line conductors and poles, but since the collecting bows had been made lighter and were better sprung, no further trouble had been experienced in this direction. The wheel base of the trucks was increased from three and one-half to five metres, and the central pivot was allowed some lateral movement.

Underground Electric Railways Company, of London.

At a recent meeting of the Underground Electric Railways Company, of London, Mr. Charles T. Yerkes gave an encouraging account of the progress of the work. Mr. Yerkes said that the company's power-house would be the largest of its kind in existence, and that the work on this was going on most satisfactorily. The electrification of the Metropolitan District Railway is progressing rapidly. The line put in and working to South Harrow has been of great service in allowing tests of machinery and materials to be made. Experiments tried in regard to safety devices have been very exhaustive, and to guard against fire, nothing with which the current comes in contact will be inflammable. The use of wood in the company's stations, for platforms and stores, will be done away with, cement and iron taking its place. The underground work on the Baker Street & Waterloo Road, between Baker street and Waterloo, is practically finished. Connection will probably be made with this line and the Metropolitan District Road at Charing Cross station. The Baker Street & Waterloo Company has also decided to extend its lines from Waterloo station to the Elephant and the Castle, and the work is now being pushed forward rapidly, while the extension from Baker street to Edgeware road is about to be commenced. After completion, this line will be carried on to Paddington. Great progress is being made on the Great Northern, Piccadilly & Brompton and the Charing Cross, Euston & Hampstead lines. The acquiring of the London United Tramways has been of great advantage to the system, and the directors intend to connect directly with the Great Northern, Piccadilly & Brompton and the District railways that line, so that passengers may have an almost uninterrupted passage from Bow, and also from Finsbury Park.

An Electric Sleigh.

During the coming winter the Allgemeine Elektricitäts Gesellschaft will conduct trials with an electrically operated sleigh on what is known as the Haidebahn, a trackless trolley on the line between Dresden and Klotzsche on which electrically propelled carriages are run for passenger transport. The vehicle will be similar to the electric carriage, but with the difference that the hind pair of wheels will be replaced by a pair of sleigh runners, and the driving wheels will be fitted with tires specially designed for taking hold on slippery surfaces. Experiments were made with a vehicle of this type last winter, and they were sufficiently successful for further trials to be made this year.

The American Society of Mechanical Engineers.

Owing to numerous delays in the receipt of papers for the December meeting of the American Society of Mechanical Engineers, the issue of the programme of the meeting will be a little late. For this reason a brief outline of the programme will be of interest.

The headquarters of the society will be as usual at the society house, 12 West Thirty-first street, where the opening session will occur on Tuesday evening, December 1, at 9 P. M. The president Mr. James M. Dodge, will deliver the annual address, the subject being "The Value of an Engineering Education to a Young Man."

The second session will occur on Wednesday morning, at the hall of the Mendelssohn Glee Club, 113 West Fortieth street, because of the limited seating capacity of the society's auditorium. This will be the business session of the convention and professional papers will also be presented. Following this, luncheon will be served at the society house, and the afternoon will be spent in making excursions to various power stations and points of interest. The evening of this day has been left free for the members to make their own engagements.

The third session will take place in the Carnegie Laboratory of Stevens Institute on Thursday morning at 10 o'clock. Luncheon will be served at the institute, and will be followed by visits to various points of interest in and about the grounds.

The usual reception for guests and friends will be at Sherry's on Thursday evening, at 9 o'clock, and will be followed by dancing and supper.

The closing session will be at the society house on Friday morning, December 4, at 10 o'clock.

The following nominations for officers of this society for the coming year have been announced by the nominating committee.

For president—Mr. Ambrose Swasey, of Cleveland, Ohio.

For vice-presidents—Professor D. S. Jacobus, of Hoboken, N. J.; Mr. M. L. Holman, of St. Louis, Mo.; Mr. William J. Keep, of Detroit, Mich.

For managers—Mr. George I. Rockwood, of Worcester, Mass.; Mr. John W. Lieb, Jr.; of New York city; Mr. Asa M. Mattice, of Pittsburg, Pa.

For treasurer—Mr. William H. Wiley, of New York city.

Single-Phase Repulsion Motors.

To the Editor of the Electrical Review:

Mr. William Cramp in his paper on single-phase repulsion motors read before the British Association and published in the Electrical Review, October 17, mentions two main difficulties in the way of the introduction of this type of motor. These are sparking at the commutator and the low power-factor. It would be interesting to know whether Mr. Cramp has tried either of the methods suggested by Mr. Alexander Heyland for overcoming these troubles in the operation of commutating alternating-current motors. The first of these is the use of a spark-absorbing resistance between the commutator segments to reduce the sparking, and the second, connecting the brushes to the secondary terminals of a small auxiliary transformer whose primary is in series with an adjustable resistance across the mains that supply the motor stator. The writer found that the latter method brought the power-factor of a two-horse-power motor completely into control, but in order to get exactly unity of power-factor, adjustment was necessary after each change of load. However, by adjusting for light loads, the motor took a slightly leading current for heavier loads, which ordinarily is not objectionable. Motors thus equipped behave very similarly to compound-wound direct-current motors.

R. M. Gaston.

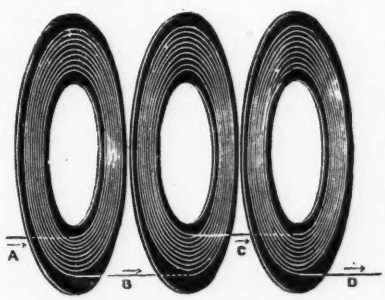
Chicago, October 27.

Road Traction by Electric Vehicles Using the Trolley Automobile.

At a recent automobile congress held in Paris, M. René Koechlin reported upon the utility of the trackless trolley, that is, an electric road vehicle drawing its supply from an overhead line. The different systems were first explained and the performance of these vehicles described. They possess many of the advantages of the electric car, climbing grades easily and turning within a very short radius. The practical speed of running is fourteen kilometres an hour. The supply is generally continuous current at 550 volts. Contrary to what might be supposed, the consumption of energy by an electric carriage is practically the same as that of a car running on rails. This is explained by the fact that these vehicles, on an average, do not weigh more than four tons, and though the power required may be twice or three times that per ton-kilometre for the electric railroad car, it is practically the same per car-kilometre. Practical tests have shown that the consumption of energy for an electric carriage varies according to the condition of the road and the grades, but for a line with grades of not more than three per cent, it is between 450 and 800 watts per car-kilometre, or about 110 to 200 watts per ton-kilometre. In climbing grades the power required is less than for the electric car, because of the lighter weight of the carriage. The price of a completely equipped omnibus is given as $3,400. It is thought that such lines should find a very useful application where traffic is light; but where it is comparatively heavy, a railroad should be built.

New Winding for Induction Coils.

A new method of winding the secondaries of induction coils has been devised by Mr. Leslie Miller, of 93 Hatton Garden, E. C., London. In this system the secondary winding is made in vertical layers one turn deep, as shown in the accompanying illustration, the successive layers being insulated from each other by paper discs. The winding is done by a machine and is continuous, without joints or crossings, the successive layers being wound alternately from the inside and



New Winding for Induction Coil.

from the outside. The advantages given for this method of winding are that an internal breakdown, due to the coming together of wires between which a high potential exists, can not possibly occur; the secondary winding can be compressed to any extent; there is a low ohmic resistance of the secondary, and the coils will stand any climate. A twelve-inch coil, when constructed by this method and worked with twenty-four volts and an ordinary mercury break, will fully light up five or six X-ray tubes at one time when connected in parallel. By a slight modification of the winding machine it can also be used for producing non-inductive resistances.

The Vienna Academy of Sciences has appointed a committee to study pitchblende, the mineral from which radium is derived. Baron Auer von Welsbach has placed his laboratories at the service of the committee during its researches.

A Sliding Railway.

The novelty of the railway system as described in the *Revue Technique* by M. G. Sautereau consists in doing away with the running wheels of the cars and replacing them with slippers or skates. The cars are raised on a thin film of water, which is forced under the skates through a jet. In the earlier plans the propelling force contemplated was a horizontal jet of water, which was directed against suitable vanes on the bottom of the cars. The valves of these jets were opened by the leading car and closed by the rear one. In the plan as at present proposed, a third rail is laid between the two gliding rails, and a friction wheel, driven by electric motors, runs on this and furnishes the propelling force. The advantages claimed for this system of traction are a great reduction in the track resistance and in the power required by a car, a much smoother running of the cars, and hence a smaller depreciation, both of track and car. There is no danger of derailment, and high speeds can be attained. By cutting off the water supplied under the skates, a great braking effect is secured. Figures are given to show the economy of the system over electric traction on wheels.

Canadian Society of Civil Engineers.

An electrical section of the Canadian Society of Civil Engineers has been formed. It will hold monthly meetings from October to April. The schedule of subjects for discussion at the various meetings of the current season is as follows: October 15, "Electrical Equipment of Some Canadian Hydroelectric Power Plants;" November 19, "Alternating-Current Motors for Traction Purposes;" January 7, 1904, "The Relative Cost of Producing Power by Steam and by Water under Different Conditions;" February 11, "Recent Developments in Electric Illumination;" March 18, "The Use of Electricity on Canals;" April 17, "Power Station Design and Operation as Affected by Recent Advances in the Design of Turbo-Electric Machinery." Professor R. B. Owens is the president of this section of the society.

Index of the Technical Press.

The October issue of the *Index of the Technical Press,* a monthly index to the technical journals of the entire world, contains over 2,000 references to articles of interest and importance. These references give the title of the article, its length, and indicate its nature. The *Index* is published in Brussels, the New York office being at 220 Broadway.

Some Notes on the Commercial Features of European Lighting Practice.

At the nineteenth annual convention of the Association of Edison Illuminating Companies, held at the Frontenac, Thousand Islands, N. Y., September 8, 9 and 10, 1903, Mr. Arthur Williams contributed an excellent paper on the subject of "Some Notes on the Commercial Features of European Lighting Practice." This paper has just been transmitted to the press for publication, and an abstract follows:

At the time of my arrival in London, the finishing touches were being placed upon the decorations erected in honor of the visit of the French President, and I was, therefore, given opportunity to make comparison between London methods and those of the larger American cities. In a general and well-designed display of banners and bunting, they were not materially different, but there was a marked absence of the use of electric light as a decorative or illuminating feature. Only a very few electrical installations were to be seen and they were on a small scale. The decorations included a great many painted signs and monograms, but none, as far as I am aware, having electrical treatment.

Likewise at the gala opera, given by command of the King, at Covent Garden in honor of the President, there were no electrical decorations, such as those in the Metropolitan Opera House in New York city for the reception of Prince Henry of Prussia. Seemingly the only additions to the permanent installation were the lamps at the temporary entrance enclosed for the royal visitors, and for the illumination of the royal box in which they sat. The auditorium was beautifully decorated with artificial flowers, but the possibilities of the decoration were not brought out as they would have been were decorative lighting freely used in addition.

There seems to have been a very great increase in arc lighting on London's streets. The prices paid by the municipality vary from $110 to $150 annually for an arc lamp of about the same size as our lamp rated at 2,000 candles. The practice is to place the lamps much nearer together, in many instances averaging not more than 100 feet apart, and the result is a degree of lighting which would offer a useful, impressive example to those in charge of that kind of service in most of our American municipalities. The city furnishes the posts and shades; the companies provide all else, giving the lamps the usual attention.

Enclosed arc lamps have made very little headway; the few to be seen are of a design less satisfactory than that with which we are familiar here, and for the most part they have not given satisfaction to the users. The reason the English engineers adhere so devotedly to the open lamps is that in London and other English and European cities, the price of labor and carbons is low, while the cost of current is high—the reverse being true in our American cities.

The Siemens-Halske company has placed upon the market a very small enclosed arc light, called the "Liliput;" in deference, I presume, to its lack of size. It is even shown in the conventional desk standard, in which heretofore the incandescent lamp has been supposed to find an exclusive field.

"Bremer" lamps are seen frequently on the streets. The outside of one hotel or restaurant on Piccadilly Circus is strikingly illuminated by them. The color of the light, however, is not pleasing, and I question whether, unless changed, the lamp will soon become very popular. It is said that about 150 are now used, with very great satisfaction, for lighting the streets of one district—that surrounding the East India docks. The lamp has recently been improved, and I understand that all now in use are to be replaced with the new type as soon as practicable. The object of the improvement is to do away with "fluttering," which heretofore has been a chronic defect. As all doubtless know, these lamps burn two in series, about fifty volts each, on a 110 to 120-volt circuit.

These lamps, as incandescent lamps and all other features of the installation, must be purchased by the consumer, but to ensure good service, the manufacturer, the Westinghouse company, arranges for their care at a cost of ten shillings, or $2.50, weekly, for two; the price including inspection, carbons and repairs, but not the current supply. The responsibility of the company supplying electric current ends at the meter, and so everybody seems to understood. This I think is not conducive to best service. It compels the customers to purchase incandescent lamps, without expert knowledge and at a price in excess of the cost of lamps to the supplying company, tending thus to prolong their use until breakage, however blackened or low the candle-power has fallen. The incandescent lighting standards are low, and as the service rendered by the companies is said to be very satisfactory—it is evident that they are carefully managed—the cause must be found in the lamps.

In the business sections one sees little gas lighting, and it is said that there is but one oil lamp installation in the city—and that that is going out. The "Lucas" lamp, comparing with the "Northern" here, is used, but apparently not to any great extent. Electric light seems to have little, if any, serious competition.

Nernst lamps, large and small, are to be seen frequently on the principal thoroughfares, and the light is of very satisfactory quality. A number of stores use them exclusively. Plain, ground or opalescent glass globes are used, with vertical spiral glowers—distinct from the horizontal straight glowers with which we are familiar in American practice. Large lamps, consuming about 250 watts, cost the retail consumer $5; small lamps, $1.25; large glowers cost fifty cents, the small, thirty-seven and one-half cents. They can be used with either alternating or direct current—those I saw using the direct current.

A Nernst projector lamp of 1,000 candle-power has been made. The lamp consists of three glowers, in parallel, placed on a white enamel disc of about two and one-half inches diameter. About 300 watts are consumed and hand control is substituted for the usual automatic control.

A representative of the manufacturers stated that 400,000 of these lamps, sixty per cent small, the remainder large in size, were sold in England during the last year. It should be remembered that the incandescent lighting standards are generally low, and therefore a greater relative growth than would be possible here should be expected.

There are thirty-six companies or vestries in London operating electric lighting plants. The aggregate of the installations, on the sixteen-candle basis, is 2,476,491 equivalents. This is largely incandescent lighting; the motor installations aggregate hardly more than 5,000 horse-power, and the arc lamps something less than that number.

It has been stated that thirteen of the companies or vestries use Wright meters, not exclusively, but in conjunction with their rates. The companies using these meters control about forty-five per cent of the total installations, but I have no data as to the number of meters used, or on the percentage of current sold through them. The manager of one of the largest companies stated that though he was reported as using this system of discount, he actually had only a few of the meters. The Shattner demand meter is also in use; one advantage being that it can be

made fast or slow, as desired, by simply changing the medium through which the balls fall.

So much has been devised and said concerning electric lighting rates that it would seem as though nothing new were possible. Yet I had not previously heard of the rate recently adopted by the St. James & Pall Mall company for long hour, usually hidden lighting; by hidden I mean the lighting of hotel, apartment house and club cellars, kitchen and servants' quarters, shops below the sidewalk level, basements and the public conveniences, which the city of London has liberally provided at the large intersections. The retail rates of this company are twelve cents a kilowatt-hour for the first 4,000 kilowatt-hours of annual use and eight cents for all over, with a discount of eight per cent on all bills paid quickly—say, within thirty days. To meet the competition of gas in the places mentioned, the company has adopted a new schedule, under which all "below street level" lighting is supplied at exactly half the usual rates. That is to say, the first 4,000 kilowatt-hours are charged for at six cents instead of twelve cents, and the remainder at four cents instead of eight cents—and the additional discount of eight per cent is also allowed.

If the consumer's premises are half above and half below the street level, he is given the benefit of a liberal interpretation of the schedule, and charged altogether at the low rates. Separate meters are provided where necessary to separate other parts of the premises supplied at the higher rates. This schedule has been very successful in competing with gas service.

Reverting again, momentarily, to rates, it may be of interest to know that one company charges twelve cents a kilowatt-hour for service at 100 volts and ten cents where taken at 200 volts. This method has been adopted, I infer, to encourage a general change of installations to the higher voltage. Another company, or rather one of the borough councils, charges sixteen cents a kilowatt-hour for the first hour of the maximum demand, and two cents for all over—a schedule representing, I believe, the extreme views of Mr. Arthur Wright in connection with the Wright demand system. Another company has recently entered upon a large contract for lighting and power service, under which the consumer pays $75 annually for each kilowatt of maximum demand and two cents for each kilowatt-hour consumed. The demand rates of this company are also interesting: for the first quarter, ending with March, the charge is, for the first six kilowatt-hours consumed per eight-candle-power lamp, or equivalent, sixteen cents a kilowatt-hour, and for all excess, four cents; for the quarters ending with June and September only the first three kilowatt-hours of average use are charged for at the higher rate, the remainder being charged for at the lower rate; the quarter ending with December, filling out the year, is again increased to an average of six units at the higher rate, as with the first quarter. Power is sold at five cents a kilowatt-hour for the first 250 kilowatt-hours of annual consumption per kilowatt of installation and two cents for all consumed in excess.

It should not be forgotten, when considering English terms, that the consumer buys everything beyond the meter, and therefore, on any prices given, fully one and one-half cents a kilowatt-hour should be added to get an American comparison.

The Shoreditch destructor works, of which so much has been said, are still in operation. This plant, it will be remembered, was erected for the purpose of burning the garbage of the district, utilizing the heat for making steam, the live steam for operating an electric light plant, and the exhaust for heating the water of the municipal bath of the district, and in winter for heating the district library. These several departments are located contiguously in the same block, but front on different thoroughfares. A second lighting station, some distance from the first, has now been erected, the capacity of which is about 1,600 kilowatts, but it is operated entirely with coal fuel. The destructor works remain substantially as they were when first finished, though because of the larger demand for electric current and the somewhat lessened supply of débris, I believe more coal is now being consumed than formerly. The consumable débris of the district amounts to 25,000 tons annually and gives sufficient heat to produce 1,000,000 kilowatt-hours. It is estimated that garbage produces on the average one-tenth the heat of ordinary coal.

Curiously, the garbage supply is decreasing. This is because dwelling-houses are being gradually replaced, as the city pushes out, by factories and stores, which in proportion contribute less. The new inhabitants, however, demand more light and power service, so that the works can well afford to burn as much additional coal as may be required.

The figures showing the result of last year's operation seem to make it difficult to prove that the electrical are paying features of the plant. There was a balance of $20,000, after all charges were met, credited to the sinking fund, but this amounts to only 1.5 per cent of the cost, a rate of depreciation demanding an active life in excess of fifty years to equal the original cost of the plant.

The use af arc lamps for the street lighting of Paris, as in London, has increased largely in the last two years, the greatest change being in the centre of the city. Open burning lamps are used, again because of the low cost of carbons and labor and the high cost of current. The lamps are spaced apart on an average not exceeding 100 feet; in some places the distances are much less. There seems to be no desire on the part of the city officials to utilize the private window lighting for the illumination of the thoroughfares, and this is well, for there is little, if any, display lighting of that order that is worth mentioning.

Where electric light is not used, there are Welsbach burners, which, with the surrounding glass case, are maintained in excellent condition. This is true of the narrowest and least important as well as of the largest and most thickly traversed thoroughfares. On some of the streets, such as the Rue de la Paix, in the centre of the city and as yet untouched by the electrical invasion, posts, supporting three lanterns, each containing a large Welsbach mantle, line up on both sides of the street, and are not more than twenty-five feet apart.

Ordinary gas burners seem to have disappeared from the shops of the city. Either Welsbach mantles, which are most common, or some similar form of burner, much larger, are mostly to be found. Some of the larger theatres and concert halls still use gas for decorative lighting, though this is true to a less extent than formerly. The maximum price of gas is $1.80 a thousand cubic feet, which also must be the minimum price, as under the law a reduction made to one gas consumer must be made to every other consumer conducting a like kind of business.

The companies supplying electric current are limited in their franchise to a maximum price equaling thirty cents a kilowatt-hour, but there is no limitation upon the extent to which this price may be reduced. The average price obtained is about twenty-two cents a kilowatt-hour.

Companies making electric current inside the city's walls pay a tax of five per cent on their gross income, while those which generate outside the walls, thus

avoiding the duty paid upon coal brought within the fortifications, pay one per cent additional, or six per cent

The cost of municipal arc lighting, where supplied by private companies, is at the rate of $240 annually, but the annual expenditure is in many cases lessened through the disconnection of the lamps at midnight or shortly thereafter. As the companies are taxed upon their gross income, this figure is reduced five per cent or six per cent, as the case may be, so that the net cost is not far from $225 a lamp annually.

At the end of 1901 the five private companies and the municipal plant of Paris had 68,267 kilowatts of installation, equaling 1,365,340 sixteen-candle equivalents. The capacity of all the stations was 38,000 kilowatts, or fifty-six per cent of the installations. 27,322,000 kilowatt-hours were sold, the consumption averaging about 400 hours per unit of installation.

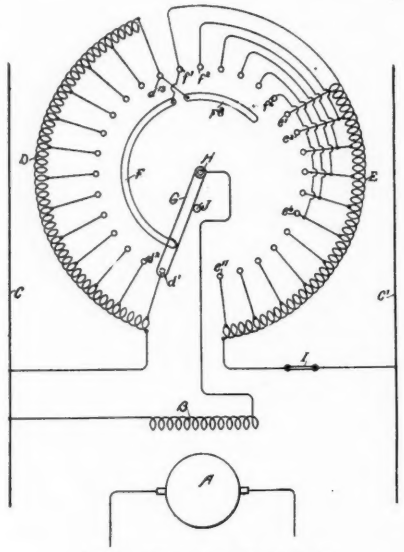
A very interesting map has been prepared by the engineer in charge of the municipal works, showing in each of eighty-three small sections, into which he divided the city, the installation capacity in kilowatts, the kilowatt-hours consumed annually, and the average use of each unit of installation. For example, one, a rich residential section, is shown where 3,387 kilowatts installation have an average use of only 161 hours annually; a second, next it, having 1,895 kilowatts, averages only 147 hours. The business and small shop sections appear better; in one 2,301 kilowatts were used an average of 585 hours; in another, 1,717 kilowatts an average of 887 hours, and in still another, 135 kilowatts averaged 734 hours. A section in which the installations are largely for city lighting, having 102 units averages 3,061 hours; another, also devoted to city lighting, having twenty-six units of installation, averages 2,284 hours. As stated previously, the average of all is 400 hours.

Tribute to Volta.

The secretary of the British Institution of Electrical Engineers reports: The bronze shield subscribed for by the students of the institution at the beginning of the present year has now been placed upon the tomb of Volta, at Camnago, Italy, near Como. The ceremony of fixing it in place was performed on Sunday, October 4, with many expressions of international good feeling, in the presence of Professor Count Alessandro Volta, Cav. Franchi, the Sindaco of Camnago, with several members of the Volta family and a number of other guests. The shield is mounted on a slab of green marble supported on granite in front of the tomb. The electotype reproduction, which was officially deposited on the tomb on the occasion of the visit of the institution in April last, has been transferred to the Civic Museum in Como, where it is placed in the collection of Volta relics.

Electrical Patents.

Mr. Leonard Wilson, of Pittsfield, Mass., has assigned to the Stanley Electric Manufacturing Company, Pittsfield, Mass., a patent recently granted to him on an electric rheostat. Referring to the illustration, A represents the armature and B the field of a separately excited generator. CC^1 are the exciter bus-bars. D and E are the resistances connected at suitable intervals to contact buttons d^1 d^2, etc., and e^1 e^2, etc., respectively. f^1 f^2, etc., are extra contact buttons connected to e^1 e^2, etc. F is a contact strip connected to f^1. F^3 is a contact strip connected to d^{13}. G is a rotary arm pivoted at H, connected to one end of field B and adapted to make contact with the contact buttons and with the contact strips F and F^1. I is a switch for opening the field and rheostat circuit. J is a stop for rheostat arm G. The operation will be

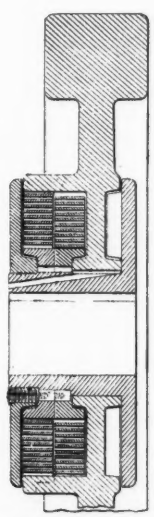


A New Type of Rheostat.

obvious: Assume, for example, that the voltage between exciter bus-bars CC^1 is one hundred and that the values of resistance of field B, of resistance D and of resistance E are twenty ohms each. Now starting with the arm G in the position shown, field B is short-circuited, and no current flows through it. As arm G is moved along contacts d^1 d^2, etc., and in contact with strip F the resistance shunting-field B is gradually increased and more and more current flows through field B until when arm G reaches d^{13} all of resistance D is in shunt or parallel circuit with field B and all of resistance E is in series with the parallel circuit. The resistance of the circuit between bus-bars CC^1 is now thirty ohms. The current is therefore three and one-third amperes, one-half of which, or one and two-thirds amperes, flows through field B. As arm G moves from d^{13} to f^1 and from F to F^3 no change in resistance takes place. Now as arm G is moved along contacts f^1 f^2, etc., part of resistance E is gradually cut out until when arm G is in contact with f^6 half of E is cut out. The resistance of the circuit between bus-bars CC^1 is now twenty ohms. The current is therefore five amperes, one-half of which, or two and one-half amperes, flows through field B. Now as arm G passes to e^1 the connection with contact strip F^3, and consequently with resistance D, is broken, while all of resistance E is placed in series with field B. The resistance between bus-bars CC^1 is now forty ohms. The current is therefore two and one-half amperes, all of which passes through field B, since field B is no longer shunted. Thus it is seen that the current through field B is not changed by moving arm G from f^6 to e^1. It will of course be understood that the step from f to e^1 may be so arranged as to produce a small change in the current passing through field B proportionate to the other steps. This could be accomplished by so arranging the contacts in relation to resistance E that a little less than half of resistance E would be cut out when arm G is in contact with f^6. Now as arm G is moved along e^1 e^2, etc., resistance E is gradually cut out until when arm G is in contact with e^{11} field B is connected directly across the exterior bus-bars. The current through field B is now five amperes, the maximum value.

General Electric Company, a corporation of New York, has purchased from James J. Wood, of Fort Wayne, Ind., a patent. The invention relates to means for preventing or reducing fluctuations occurring in rotary motor devices, such as steam engines, turbines, impact-wheels, or other prime movers, as well as secondary motor devices, such as dynamo-electric machines, electric motors, rotary converters, and the like. The invention is applicable whenever in such a rotary motor fluctuations from a uniform rotation are liable to occur by reason either of variations in the propulsive energy or variations in the work or load, which variations recur at frequent intervals, so that they tend to produce alternate accelerations and retardations of the motor, such as are known in the art as "hunting" or "pumping." Another application for patent still pending covers a device for preventing such fluctuations particularly with reference to synchronous dyna-

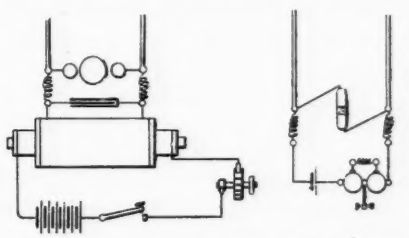
mo-electric machines, such as alternating motors or rotary converters. In operating such machines, the hunting or beating action is usually indicative of some irregularity in the circuit feeding the motor. This irregularity may consist of variations either in speed or in electromotive force. The variation in speed of the generator tends to cause a corresponding variation in the speed of a synchronous motor. The motor can not, however, assume instantly the speed required by the new speed of the generator. When the speed of the generator increases, the motor-armature begins to increase in speed; but by reason of its lagging the motor receives an increased current, because its armature is not in normal position for the new frequency and because additional current is required for supplying the energy necessary for increasing its speed. This additional current produces a difference of magnetism of the field, which must again be altered when the generator speed decreases below the aver-



SECTION OF FLYWHEEL AND SLEEVE, SHOWING ARRANGEMENT OF SPRINGS.

age. The motor is therefore undergoing a slight variation in speed, which seeks to approximate to, but does not exactly correspond with, that of the generator. As set forth in the application with particular reference to synchronous alternating motors, the inventor overcomes this defect and avoids interference with the line by applying to the shaft of the motor or a shaft rotating therewith a flywheel of suitable weight, which is yieldingly connected to the motor, preferably by being free to turn upon its driving-shaft, a spring connection being interposed between the flywheel and its shaft so as to oppose relative movements of the motor and flywheel in either direction. The degree of such relative movement preferably corresponds to the angular distance between two adjacent poles of the armature. The spring connection therein shown comprises a coiled spring or springs interposed endwise between abutments formed upon the flywheel and its shaft, said springs being compactly arranged between these parts and suitable stops being provided for limiting the strain upon the springs. While well adapted for use with motors in which the angle between the poles is not considerable, as is the case with motors having a relatively great number of poles, difficulties have been encountered in adapting such devices to motors having comparatively few poles. This is due to the fact that because of the relatively great angle between the poles springs of this character are not well adapted to permit the necessarily extensive rotary movement of the flywheel in a connection which provides the requisite compactness, durability and strength. In the later invention the aim is to provide a construction which is especially adapted for use with motors having two or more poles, while retaining the advantages of the construction just described. In its preferred form the invention which provides a connection between the flywheel and its shaft, which comprises a pair of spiral springs, preferably involute springs, each connected at its opposite ends to the flywheel and its shaft, respectively, and the springs reversely arranged so that relative movements of the flywheels and shaft in both directions are resisted by the tension or compression of the springs exerted in such manner as to tend to wind or unwind them. The springs preferably encircle the axis of rotation of the flywheel and are suitably housed or enclosed, preferably within the flywheel. Certain other features of improvement are provided in the construction and arrangement of the parts.

An English electrician, Mr. Sidney G. Brown, of Bournemouth, England, has patented in this country an improvement in a system of wireless telegraphy. Accordingly the transmitter apparatus is provided with two radiating wires coupled one to each terminal of the sparking device, and the receiving apparatus is provided with two receiving wires coupled one to each terminal of the coherer. These radiating and receiving wires are respectively placed at a distance apart which has a definite relation to the length of the signaling waves, that of half a wave-length or approximately half a wave-length being the most convenient distance. This placing of the wires half a wave-length apart causes the system to send its waves or to receive them from mainly one direction, which direction would seem to be that of the plane of the wires. If the vertical wires were not so carefully adjusted to the wave-length, they would transmit or receive the Hertzian waves from any direction. By arranging a condenser across the high-potential terminals of the spark coil and joining the terminals of this condenser to the spark-balls through highly inductive coils, the persistence of the waves can be increased, the conductor acting as a storage of power and maintaining the condenser at each side of the spark-gap. The highly inductive coils prevent the charge in the condenser from oscillating across the spark-gap. By thus increasing the persistence of the train of Hertzian waves due to each disruptive discharge the receiving circuit can be caused to be in tune or syntony with the transmitting circuit, thus rendering the system more sensitive and less likely to be interfered with by neighboring systems differently disposed. The wave-length that any system may generate is to a certain extent under command, and it is necessary if parabolic reflectors are to be used to keep the waves



SHOWING SENDING AND RECEIVING APPARATUS, WIRELESS TELEPHONE SYSTEM.

short. This can be done by suitably arranging the spark-gap, such as by employing suitably sized intermediate balls or by placing inductive coils in the arms of the radiating wires. By thus keeping the length of the waves short the use of parabolic mirrors behind the radiating and receiving wires and within a much shorter distance of said wires than that of their length or half their length is rendered possible. These mirrors which should be constructed of reticulated metal, such as fine wire netting or its equivalent, have the effect of reflecting the waves to or receiving them from one definite direction, and thereby restricting the wave or telegraphic effect to a given direction. The coherer preferably employed is electrically or magnetically controlled in such manner that immediately after a signal has been received the electric or magnetic controlling force decoheres or renders the coherer non-conductive without the intervention of a mechanical tapping device, thereby increasing the speed of signaling.

Reviews of Current Engineering and Scientific Literature.

Locomotives or Motor Cars?

For the three classes of service—fast long-distance passenger and freight, local passenger, and slow freight—different classes of motive power seem suitable to Mr. B. Pontifex. For express traffic he believes a locomotive is safer and more satisfactory, as a train drawn from the head is less liable to derailment at crossings and switches than when propelled by motors distributed throughout the entire train. Although the latter method of equipping makes possible a higher rate of acceleration, on the whole, the running time of the train would not be increased, due to the necessity of slowing down at all switches and crossings. On the other hand, for local passenger traffic, quick acceleration is most important, and for this purpose the motor should be distributed throughout the train. Motors should be placed on the inner axles of each truck, as this arrangement gives an increased acceleration and results in a smoother running and decreased hammering at curves and at switches. For slow freight traffic locomotives alone meet all requirements. —*Abstracted from the Electrical Engineer (London), October* 16.

Iron Losses.

The curious result that the iron loss in dynamos is about two and one-half times what it is in transformers for the same maximum density has led Mr. A. Press to seek for an explanation. It is usual to assume that the flux wave in transformers is the sine function of the time, and that the flux distribution in a dynamo is of the nature of a flat top wave. The apparent discrepancy may be possibly explained by an increase in eddy loss due to the character of the distribution curve. Continuous-current machines are first examined, and it is found that this distribution having a minimum eddy loss for a given area included under the curve and a given base is the parabola which approximates closely to a sine wave. The conclusions reached are that the great difference between transformer losses and dynamo losses can be explained in greater part by taking into account the slope of the flux distribution wave; that the so-called full load increment in iron loss can be in a measure accounted for by the skewing of flux due to cross-magnetization, and that the ideal distribution curve is a parabola degenerating into a flat top with parabola sides, for a minimum total iron loss. For alternators the most efficient sort of flux distribution is found to be a sine function. For machines of low frequency, where the hysteretic constant is more important than that for eddy currents, a flat top wave should be aimed at; but where this constant is practically negligible compared with that for eddy current, the flux should spread to one and three-quarter times the width at the top. The degree of peakedness is determined by the amount of maximum density and effective electromotive force required. Arnold, as the result of his investigations, found that the sine wave was the best form of flux distribution, but his point of view is entirely one of effective electromotive force against a given flux.—*Abstracted from the Electrician (London), October* 16.

Tangental Traction.

This is a study by MM. L. Rosenfeld and C. Zelaney of a so-called tangental traction system. In this system three-phase currents are employed and the propelling force is produced by a method similar to that which causes rotation in induction motors. What corresponds to the primary of the motor is here buried in the street between the rails. The part corresponding to the secondary, here called the propeller, is suspended from trucks just above the stator. The reactions set up by polyphase current in the winding of the buried stator so react upon the propeller above it as to cause it to move in one direction or the other. The application of a system of this kind encounters a number of serious difficulties. One of these is the poor power-factor which under ordinary conditions would be caused by the necessarily large gap between the stator and the propeller. The power-factor here is brought up to a satisfactory figure by increasing the breadth of the air-gap, by means of polar extensions built up of plates lying at right angles to the plates of the cores of the primary and secondary. In this connection some interesting results of tests on motors constructed upon the same principle are given. Another objection is the large power which would be required if the potential were applied continuously to all coils at the stator. This difficulty is removed by grouping the stator sections and introducing an automatic switch for connecting these sections to the feeders as the car passes them. The automatic switch is a small three-phase induction motor, the stator being connected in circuit continuously. The rotor has a coil winding, the ends of which are connected to the two wheel rails which are insulating. This winding then remains open except when a car is on that section of the track. When the circuit is closed by a car, the rotor closes the switch throwing that section of the stator on the feeders. After the car passes, a counterweight opens the switch. The speed of the cars is controlled by means of resistance in the propeller circuit. An experimental track has been installed, the dimensions of the various parts being given, but no results of tests are yet available. — *Translated and abstracted from Bulletin No.* 6, 1903, *of the Association Des Ingeneurs Electriciens, Liege.*

Three-Phase Switch Gear.

This series of articles by Mr. A. C. Eborall criticises the so-called cellular type of switchboard for high voltages and discusses in detail the desirable features of switchboards for high-tension work. The whole of the high-pressure gear should be removed from the operating platform and isolated in fireproof compartments. All high-pressure fuses should be done away with. High-pressure bus-bars should be arranged in such a manner that any portion of them can be isolated. They should be provided with properly arranged pressure discharges and so arranged that the attendant has no excuse for getting confused. All high-pressure switches should be controlled from a distance, because in this way not only can one man control effectively all the switching gear without becoming nervous on account of the presence of conductors carrying high voltages, but the apparatus itself can be distributed without being crowded into too close quarters. Switches should be of the oil-break type, automatically operated. The following arrangement of protective devices is recommended: automatic non-overload switches with reverse-current attachments on the generator panels; automatic overload switches with time attachments on the feeder panels; automatic overload switches with reverse current and time attachments on the feeder panels; automatic overload switches with time attachments on the machine panels

and the substation switchboards. The conclusions which the author draws from the study of the switch gear are: never break a circuit in air; arrange all circuits so that the voltages produced by the oscillations in opening a transmission line are moderate; and provide excess-pressure discharges at different points of the system. The best form of excess-pressure discharges is the horn type in series with a high non-inductive resistance. In many cases cable-charging apparatus will not be found necessary. If power-driven switch gear is necessary, electrical means, rather than pneumatic, are recommended. —*Abstracted from Engineering* (London), *September* 25, *October* 2, 9, 16, 1903.

Trial of the Diesel Oil Engine.

A trial was recently made on behalf of the Belper Rural District Council, England, at its Lee pumping station, to ascertain whether the guarantees given by the makers of the pumping plant had been fulfilled. The results of this trial are given in detail here by Mr. M. Longridge. The plant consists of two units for alternate use. Each unit comprises one thirty-horse-power Diesel oil engine and one horizontal Reidler pump, the two being coupled together by spur wheels keyed on the engine shaft and pump crank shaft, respectively. Each engine is an inverted vertical type with cylinder 11.8 inches in diameter by 18.12 inches stroke. The normal speed is 180 revolutions per minute. To make the trial, the pump was disconnected, a brake being put on the flywheel of the engine. It was found to run very readily. The pull was shown by a spring balance. The oil used was said to be Texas crude oil, the calorific value corresponding to chemical analysis being 18,735 British thermal units per pound. The same value, determined in a Berthelot-Mahler bomb calorimeter, gave 19,080 British thermal units; or, deducting the heat of evaporation which is not available in the engine, leaves 17,900 British thermal units. A number of trials were necessary before the proper conditions for testing were ascertained; but after all parts had been adjusted, a run was made which gave the following results: The test lasted sixty minutes; the speed of the engine was 177.7 revolutions per minute; pressure of the air in the receiver, 645 pounds; maximum pressure in the cylinder, as shown by the indicator, 498 pounds; temperature of the exhaust gases, 379 degrees Fahrenheit; the total oil used, 8.687 pounds; mean effect of pressure, 53.4 pounds per square inch; indicated horse-power, 23.75; brake horse-power, 14.76; mechanical efficiency of the engine, 62.2 per cent; horse-power expended in friction, 8.9; oil consumption per indicated horse-power-hour, 0.366 pound; per brake horse-power-hour, 0.585 pound. Tests made at other loads show that the consumption of oil per brake horse-power-hour was minimum at the normal rate of thirty horse-power.—*Abstracted from the Mechanical Engineer* (*London*), *October* 3.

The Central Station Auxiliary Plant.

The auxiliary plant of the power station is often the most inefficient part of the installation. Mr. F. H. Davies here considers this phase of station design, and points out what seems to him to be a desirable method. The most important auxiliaries are the pumps, and these are most often driven by steam. In many cases electrically driven pumps would be more efficient, but a rigid rule can not be laid down. If the pump is used intermittently, steam operation is very inefficient, and under such conditions electrical driving should, in general, be used. The average small steam pump efficiency is said to be about twenty-two per cent. Better efficiencies are obtained in large stations, but, under good conditions, it is only about half of that of an electrically driven pump. An objection to electrically driven pumps is the difficulty of regulating efficiently the supply of water. When a series resistance is used, the efficiency may be less than that of the steam-driven pump. Shunt resistance does not give a wide range of regulation and is apt to cause sparking. The use of a by-pass to the pump is wasteful and inefficient. Series parallel control is efficient and gives a wide range, but requires an expensive motor. When three-throw pumps are used, an efficient method of control is to cut out one or more plungers, but this does not give close regulation and is apt to cause dangerous water hammer and straining in the delivery pipes. Variable gear is noisy and inefficient, and does not give a wide range. The conclusion reached is that the series parallel control is the best system; but, to guard against breakdowns, it is advised that both steam and electrically driven pumps be installed. Injectors for boiler feeding are not satisfactory, as they are unreliable and inefficient. For stoking and economizer gear, electrical driving is to be recommended, as the service is continuous. The economizer scraping gear should be run from the stoking motor. For source of power, single-phase alternating current is not satisfactory, and while plants of this type in some cases run motors from the exciter bus-bars, this is strongly objected to, as the exciter service should be maintained for that work alone. The power should be distributed to the auxiliary motors in a systematic way, and should be measured and the circuits protected by automatic apparatus.—*Abstracted from the Electrical Review* (*London*), *September* 25.

BOOK REVIEW.

"Electrical Engineering Measuring Instruments." G. D. Aspinall Parr. New York. D. Van Nostrand Company. Cloth. 6¼ by 9 inches. 328 pages. 370 illustrations. Supplied by the ELECTRICAL REVIEW at $3.50.

This book treats of the construction and principles of operation of present types of ammeters, voltmeters, wattmeters, phase meters, frequency meters and electricity supply meters. There is an introductory chapter on the general classification of these instruments according to the methods of their operation and upon the controlling forces, sources of error, and compensating devices. The next three chapters treat of moving-needle, moving-coil, hot wire and electrostatic instruments. Then follow chapters on electromagnetic wattmeters, recording instruments, standard instruments, and supply meters. Over one hundred instruments of different manufacture are described and illustrated. Among these are but half a dozen of American make. The American reader can not fail to be impressed with the large number of low-grade instruments which appear to be worthy of the consideration of the author. The English engineer has more patience with gravity control, with non-uniform or parabolic scales, and with strings to be pulled than his brother Jonathan. The descriptions are in the main clear and the illustrations good. The book can not fail to be of great value to any one who is interested in the subject.

The Independent Telephone Association of Southern Indiana.

The following programme has been announced for the fourth annual convention of the Independent Telephone Association of Southern Indiana, which will be held at Evansville, November 10 and 11:

Tuesday, November 10, 2 P. M., address of welcome by the Mayor of Evansville. Response by the president of the association, Mr. G. A. Kienle. Paper on "The Situation in Evansville," by the Hon. A. W. Funkhauser, followed by general discussion and the appointment of committees.

Wednesday, November 11, 9.30 A. M., paper on "Long-Distance Lines," by the Hon. Charles D. Knoefel, New Albany, Ind. Paper on "The Bell People as Antagonists," by Mr. A. J. Payton, of Rockford, followed by discussion.

The discussion of these papers will be followed by the reports of committees and the election of officers.

On Tuesday evening a special entertainment will be arranged for by the citizens of Evansville and the Evansville Telephone Company.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

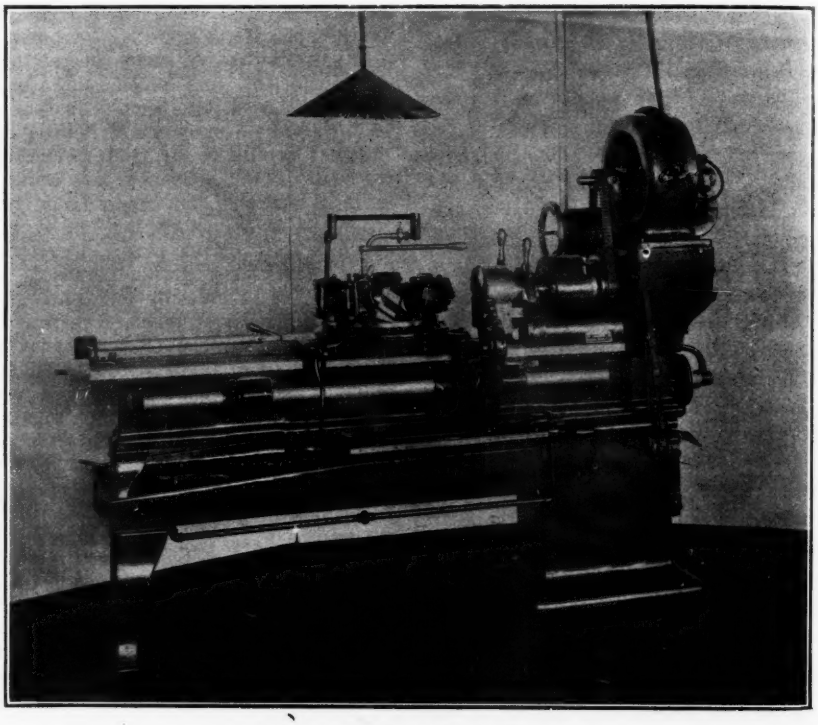
A Turret Lathe, Motor-Driven.

Combine with a machine tool well known for its rapid and accurate work, the use of motor drive with variable speed control, and the result is a close approximation to ideal equipment. Such an outfit is shown in the accompanying illustration, which represents a Hartness flat turret lathe driven by a Crocker-Wheeler form "F" motor. It is a machine for doing general lathe work, in sizes not exceeding two inches in diameter and twenty-four inches in length. Hence it is known as a two by twenty-four lathe, although with special appliances it may be fitted to take bar stock as long as thirty-six inches, or chucked work up to fourteen and even sixteen inches in diameter. Naturally, the maximum economy effected by its use is realized when turning quantities of identical pieces. On such work it is usually allowable to make the limit of variation each way from nominal size 0.0005 to 0.001 of an inch, but at a sacrifice of output it is possible to work as close as 0.00025 of an inch.

Among the distinguishing features of the lathe may be mentioned the peculiar form of the turret, its independent feed stop for each position, the roller feed for advancing the work at the conclusion of each cycle, and the swinging die carrier. The turret is a flat circular plate mounted on a low carriage containing the controlling mechanism. Its power feed is actuated by a worm screw which may be disengaged by an adjustable stop for each individual position. In operation as soon as the turret clears the work on its backward travel it is automatically revolved to the next position, or by an arrangement of trip screws near the centre of the plate it may be caused to turn through three, four or five of its six positions before stopping. The roller feed is mounted on the outside of the headstock and pushes the bar of work through the hollow spindle and chuck until it strikes a stop on the turret carriage. The rolls then slip until the chuck is closed, as they are started and stopped by the same lever that opens and closes the chuck. With the latter is provided a set of interchangeable jaws to take all shapes and sizes of rough stock between two and three-eighths of an inch. The die carrier is mounted on a sliding bar on the back of the frame and arranged to swing into working position. It holds a die of any kind and a pointer for shaping the ends of shafts and bolts, or reducing stock. In this way, two extra operations, or eight in all, are made possible to the one lathe.

A substantial construction is maintained in the headstock to afford strength and the rigidity essential to accurate performance. The motor has a capacity of five horse-power at 1,100 revolutions per minute and 240 volts, and is mounted directly over the spindle which it drives by means of a Renold silent chain. Beneath the spindle is placed the regular back-gear, and when required for large diameter work a triple back-gear is placed below the regular one. The gears are thrown in or out of operation by friction clutches, so that it is not necessary to stop running while making the change. From the motor to the sprocket on the spindle there is a three to one speed reduction, the first back-gear reduces again by a ratio of four to one and the second gives sixteen to one from sprocket to spindle. The motor being supplied with current on the four-wire multiple voltage system of the Crocker-Wheeler Company is capable of six speeds by the separate voltages and six more by the use of one resistance or twelve in all in either direction. Its highest speed is 1,100, which transmitted direct to the spindle turns the latter at about 370 revolutions per minute. The motor's slowest speed, 162, communicated through the triple back-gear makes the slowest speed of the spindle three and one-third revolutions. Between these limits there is a total of thirty-six different speeds in direct or reverse rotation.

The Hartness flat turret lathe is manufactured by the Jones & Lamson Machine Company, of Springfield, Vt.



TURRET LATHE, MOTOR-DRIVEN.

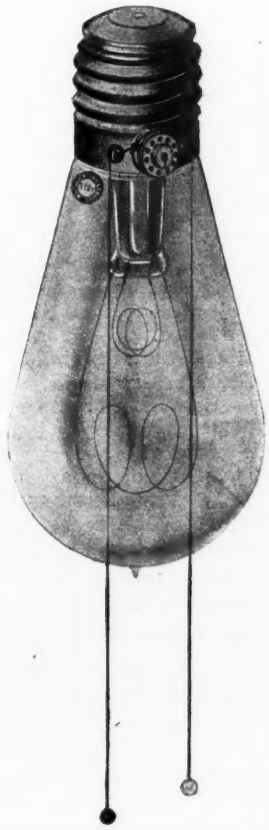
The Vulcan Ammeter.

A new ohmmeter, adapted especially for wiring contractors and others in similar positions, is being made by Geipel & Lange, of London. The meter is an adaptation of the Wheatstone bridge, and operates without plugs. It is contained in a wooden case having a graduated cursor bar and a five-pointed slide switch. The resistance to be tested is connected to two binding-posts at one end of the box, and the two slides are adjusted until the needle of the galvanometer contained in the box does not deflect. The resistance is then read off directly. The range of the instrument is between one ohm and 20,000,000 ohms, making it suitable for a workshop instrument for measuring the resistance of wire or of insulation.

New Types of Incandescent Lamps.

The Rooney-Westbury Electric Lamp Company, New York city, has designed two new types of incandescent lamps which are unique in their construction and merit description.

The "Sun Star" lamp has been designed under the company's two-carbon lamp patent, to meet the requirements of a lamp which will give a sixteen candle-power or a lower candle-power, as desired. The two filaments are in parallel, so that while the large filament takes the usual amount of current, the small filament, which is a regular miniature lamp fila-



TWO-FILAMENT LAMP FOR TURNING DOWN.

ment, only requires one-tenth of an ampere, and if one of the filaments should burn out, the other filament can be used for the extent of its life.

The other lamp is a two-carbon lamp with the two filaments placed in parallel, so that they can be used either singly or together, as may be desired. It is claimed that this lamp will give twice the life of an ordinary single-filament lamp. Where the user desires to save current, he can use the two carbons at once, which will enable him to save current and at the same time obtain the same life as with the ordinary lamp. This type of lamp is manufactured in the following candle-power for each filament: two-candle-power and four-candle-power filaments; two-candle-power and eight-candle-power filaments; two-candle-power and sixteen-candle-power filaments; one four-candle-power and one eight-candle-power filaments; one eight-candle-power and one sixteen-candle-power filaments. Any other combination can be made up specially if desired. It must be understood, however, that where two filaments of different candle-power are placed in the same bulb, they can not be burned together, but only one at a time. Lamps are manufactured in all voltages from 100 to 120.

The operation of changing the filaments is simple, necessitating only the use of a small screw-driver. When one filament burns out a contact screw is loosened for a few turns and the connections to the old filament around this screw is released, and the connection to the other filament brought over and placed in contact. The screw is then again tightened and the lamp replaced in the socket.

Where it is desired to have the two filaments burn together, the first wire is left around the screw and the other wire also brought around the screw, causing both filaments to light up at once.

The lamps are made of the best material, are perfectly exhausted, and carefully tested and photometered, with the design of making lamps of the best quality.

The turn-down lamps are fitted with either a screw arrangement on the base, or, if the lamp is to be used out of reach, it is fitted with a bar arrangement, and two strings, depending therefrom, marked, respectively, "bright" and "dim," are attached.

The Power-House of the Valley Counties Power Company.

At the Nimshew power-house of the Valley Counties Power Company, a subcompany of the California Gas and Electric Corporation, the first two machines have begun operation, feeding into the transmission line of the Bay Counties Power Company.

The power-house is located in the Butte Creek Cañon, twenty-four miles from Chico. The available total head of water is 1,531 feet, taken down in one pipe line 6,200 feet long, and tapering in three sections from thirty to twenty-eight and one-half inches in diameter. Within the power-house the pipe terminates in a Y, each branch of the Y supplying a 3,700-horse-power water-wheel, the largest wheels operated as yet by one single jet of water.

The generators are of the Stanley Electric Company's make, the rotary element mounted on one single shaft with the water-wheel. The entire hydroelectric unit runs in two bearings, the rotary element of the generator between the bearings, and the water-wheel overhung.

The shaft is of nickel steel, hollow forged and oil-tempered, and the disc is a nickel steel forging, both made by the Bethlehem Steel Company. The buckets are steel castings of the patented ellipsoidal type. The total weight of the revolving part of each unit is over forty tons, and the speed is 240 revolutions per minute.

Each water-wheel is provided with a Doble patented needle-regulating deflecting nozzle and hydraulically operated piston gate. A Lombard type D governor with electric speed control takes care of sudden fluctuations of the load by deflecting the nozzle, and the regulating needle is operated by hand and set according to the average load of the respective hours of the day.

The hydraulic machinery, including the shaft, bearings and gates, was designed and built by the Abner Doble Company, of San Francisco, Cal.

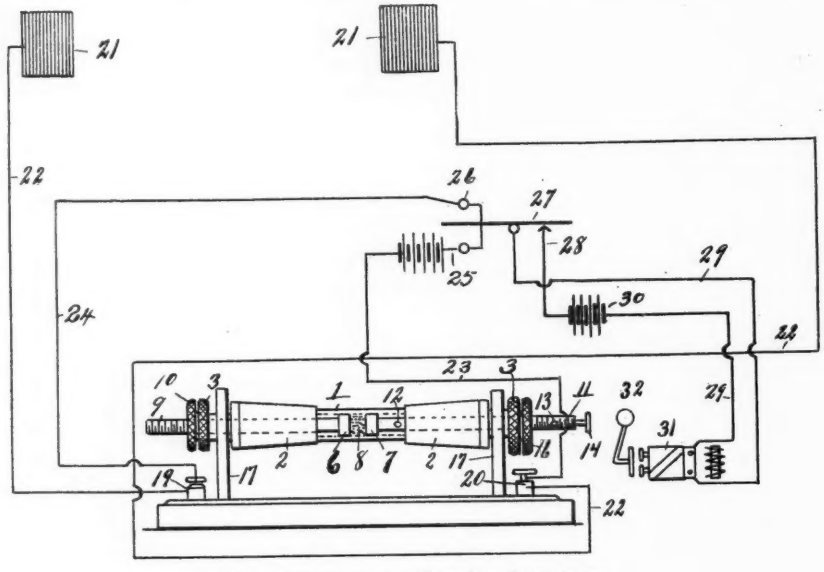
Results of the Application of Electrical Traction to the Wannseebahn, Berlin.

The London *Electrician* quotes some interesting remarks made by Herr Bork, before the Verein für Eisenbahnkunde, relative to the application of electric traction to the Wannseebahn, Berlin. The average power consumption per ton-kilometre was found to be twenty-two watt-hours in summer, and 23.3 watt-hours in winter months. The efficiency of the feeder system is said to be 97.7 per cent, and that of the distributing system along the track, 96.4 per cent, that of the batteries being ninety-one per cent. Originally the resistance of one kilometre of line for conducting energy to and from the station was 0.044 ohm, but this has since been reduced to 0.04 ohm. The average insulation per kilometre of track was found to be 500,000 ohms, the lowest measure being 16,000 ohms. With a length of line of twenty-five kilometres and a working pressure of 700 volts, 22.5 watts are thus lost. Working costs per thousand train-kilometres are given in the case of electric traction as 1,065.9 marks, and in the case of steam traction, as 1,065.5 marks.

A New Coherer for Wireless Signaling.

The accompanying illustration shows the diagram of the circuit and the application of a new type of coherer for wireless signaling, invented by Mr. Thomas E. Clark, of Detroit, Mich., and for which patent No. 741,767 has been issued. This invention has been assigned to the Thomas E. Clark Wireless Telegraph-Telephone Company, Detroit, Mich.

The objects of the invention are to provide simple and effective means for receiving the impulses or Hertzian waves, capable of such adjustment as to ensure the operation of the receiving apparatus by light or feeble impulses, and enabling the reproduction of these impulses in the signaling apparatus, at the same time providing for decohering the coherer after each impulse is received.



NEW COHERER FOR WIRELESS SIGNALING.

A further object is to provide means whereby the coherer may be readily detached without disconnecting any of the circuit wires, and a second coherer quickly replaced in the receiving apparatus so as to enable an exchange of coherers should one fail to operate, or to enable the introduction into a circuit of a coherer of different adjustment, where the character of the impulse might require such a change.

Referring to the illustration, Fig. 1 is a glass tube provided at its ends with hard rubber or ebony caps 2. These caps are sealed or cemented on the end of the tube. Contact terminals 3 are provided with threaded ends, adapted to screw into the rubber caps. These contact terminals have longitudinal openings extending through them, which receive the stems of the electrodes 6 and 7, respectively, which pass through the contact terminals and enter the glass tube from opposite directions. These electrodes may be formed of any suitable material, but are preferably made of phosphor-bronze, and confine between their adjacent faces within the glass tube the metallic filings 8. The stem of the electrode is threaded so as to enable it to be screwed through the contact terminal, whereby any desired adjustment of the electrode longitudinally within the glass tube may be accomplished. A lock nut 10 screws on to the stem of the electrode for the purpose of locking it after adjustment. The stem of the electrode 7 is provided with a channel running longitudinally through it and opening at its inner end into the interior of the glass tube, the outer opening of the channel allowing the air to be withdrawn from the glass tube so as to obtain nearly a perfect vacuum within the tube. After the air in the tube has been exhausted, a needle-point valve 14 is screwed into the end of the stem of the electrode, closing the channel and maintaining the vacuum. The stem of this electrode is also externally threaded, so that it may be screwed through its contact terminal to effect a perfect adjustment of the electrode, and is secured by the lock nut 16.

The adjustment of the electrodes allows the distance between their adjacent faces to be regulated to increase or decrease the resistance across the filings accompanying the space between them. The contact terminals are provided with flat sides adapted to be received between the opposed contact jaws 17 at each end of the coherer. These contact jaws are mounted upon a hard rubber base. The binding-posts 19 and 20 are connected electrically to the jaws, and the aerials 21 are connected, through their conductors 22, with these binding-posts. Circuit wires 23 and 24 are also connected with these binding-posts, and in this circuit is included a battery 25 and a relay magnet 26. The circuit is normally open at the coherer.

When an electrical impulse is received at the receiving station the wave train is taken up by the aerials and passed along the conductors to the coherer. This operates to cohere the filings in the receiver and close the relay circuit between the electrodes. In this relay circuit may be placed any suitable instrument for recording pulsations. Upon the closing of the relay circuit, the armature 27 is contracted to close at the point 28, the auxiliary circuit 29, including the battery 30, and the electrical tapper 31, the hammer 32 of which is operated to strike the end of the screw in the stem of the electrode and decohere the filings, thereby opening the relay circuit as soon as the impulse is received.

An apparatus of this description enables the tube forming part of the coherer to be readily evacuated, and also makes it possible to change the coherer in the contact jaws if this becomes necessary through failure of this part of the apparatus, or through the necessity of making a different selection in the adjustment of the electrodes in any coherer.

A Small Arc Lamp.

A miniature arc lamp which works with one and one-half to two amperes and burns for about forty hours with one trimming is being put on the market by the Arc Lamps Company, Limited, 62 Old Broad street, E. C., London. The lamp is about sixteen inches long and runs on 100 or 110-volt circuits. It is simple, is said to burn steadily, and gives a soft, clear, white light. The lamp is suitable for interior lighting and also for lighting side streets.

An Electromagnetic Railway Coupling.

An electromagnetic car coupling was described in a recent issue of the *Elektrotechnischer Anzeiger*. This takes the place of the usual coupling or of the two corner bumpers used on European cars. The coupling consists of two parts, having a spherical surface, into one of which is sunk the exciting coil. The couplings are thirty-seven centimetres in diameter, and each gives a pull of 8,400 kilogrammes. The power required is forty watts, which is supplied from a small storage battery.

A Statement from Mr. Milo G. Kellogg to the Customers of the Kellogg Switchboard and Supply Company.

Mr. Milo G. Kellogg, former president of the Kellogg Switchboard and Supply Company, Chicago, Ill., has issued a statement to the customers of the company, under date of November 2, 1903. This statement sets forth in detail the conditions which led up to the disposition of his share of the stock of the Kellogg company, and his subsequent efforts to recover this.

It appears that in the summer of 1901 Mr. Kellogg became ill, but, under the care of a physician, was able to give some attention to business until about the middle of November, when he was obliged to give up all work and care and leave at once for California, to be gone for an indefinite length of time. During the last half of the year of 1901 the capacity of the Kellogg company for the transaction of business was practically doubled at a large outlay, part of which was met by the sale of the remaining treasury stock of the company, and the remainder, to the extent of $250,000, was to be met by an increase of the capital stock, which was under way when Mr. Kellogg was obliged to leave. During the month of December it became apparent that the Everett-Moore Syndicate would not be able to care for the paper which they had given the Kellogg company to the amount of $222,000, which the company had discounted, and which would mature during the following two months.

At this time it was not expected that Mr. Kellogg would ever recover his health sufficiently to take up active business again. It was therefore thought best by Mr. De Wolf, the vice-president of the company, who had general charge of the business of the company, and to whom, in the absence of Mr. Kellogg, had been given the general power of attorney to transact all business connected with Mr. Kellogg's personal property, to make a sale of the stock, by which the funds needed by the company could be secured, while Mr. Kellogg and his estate would be relieved of the care and responsibility connected with the controlling interest in so large a business. Assisted by Mr. Buckingham, of Chicago, a capitalist and a director of the company, it is stated that Mr. De Wolf disposed of a portion of the stock to Mr. Barton, of the Western Electric Company. Mr. Kellogg states that he was not aware of the transaction until July 4, 1902, six months after it occurred. The stock which Mr. De Wolf disposed of, and the contract of sale including Mr. Kellogg's stock and his own and Mr. Buckingham's, amounted to more than three-quarters of the stock of the company, Mr. Kellogg's holdings amounting to about two-thirds of the company's stock.

As soon as Mr. Kellogg learned of this matter he at once sought the assistance of Judge R. S. Taylor, of Fort Wayne, to attempt to recover without any legal proceedings the stock which he announced had been disposed of without his knowledge and without his consent. The statement includes the correspondence between Mr. Kellogg, Judge Taylor, Mr. Barton and others.

Mr. Kellogg's efforts to repurchase the stock were unsuccessful. A bill in equity, to obtain a decree of court which should declare that the sale of Mr. Kellogg's stock was unlawful, was filed by some of the minority stockholders in June last, to which Mr. Kellogg was made defendant. Mr. Kellogg's counsel, in view of all the circumstances, being of the opinion that the transaction would, upon his application, be held void, and he restored to his former position of ownership, have filed to that end a cross bill to the case in which he has been made a defendant. The case is to be argued on demurrer within a short time.

Trafford City, Pa.

The site of the foundry to be operated by the Westinghouse interests at Trafford City, Pa., which was recently described in these columns, affords opportunity for many unique experiments in economics. One of the most interesting propositions is the large new hotel, Trafford Inn. This building is centrally located at a junction of two of the principal streets, and is designed to fulfil not only the requirements of a first-class hostelry but, recognizing the desire of the members of the community for amusement, to supply also many of the features of a casino. By according these dual functions to one building, it becomes the central feature of the community and, having this idea in mind, it has been very strongly and handsomely constructed of pressed brick with stone trimmings, thus presenting an appearance of substantiality and attractiveness to which all the buildings of the town must conform in order to seem at all in keeping with it. It is of a size sufficient to accommodate seventy-five guests, the general internal arrangement being modeled on the bachelor club plan, the idea being to provide, to the well-paid employés of the foundry who have no families, such comforts and accommodations as will render occupation at the Trafford plant most desirable. This scheme is really an experiment in sociology, the rates charged being such as are not expected to yield any profit. The rooms are arranged singly and in suites with convenient bathroom and toilet conveniences. The interior finish of the rooms is such that they can be made attractive with very little embellishment, and the lighting and heating facilities, furnished from the main power plant of the foundry, aid in making these accommodations comfortable. A large reading room of the first floor adjoins the dining room, and these two rooms by being thrown together can be used for meetings and entertainments. The basement is devoted to a billiard room, bowling alleys, etc. On the same level is a row of eleven brick apartment buildings, two stories high, with a flat on each floor, arranged to accommodate one family.

The city site has been laid out into 2,000 building lots and space has been left for several parks, all of which are thickly wooded. The principal business streets and a portion of the residence streets are paved with brick with curbed flagstone sidewalks. The Philadelphia Company, of Pittsburg, has piped the town with natural gas which is available for illumination and domestic purposes.

A handsome brick passenger station is under construction by the traction companies, with commodious waiting rooms for passengers. Sites for several churches have been purchased, and school buildings have also been projected.

The entire town has been piped for water by the Trafford Water Company, and an abundant supply of excellent filtered water from the Allegheny river is obtained. A complete sewerage system has been installed, which includes separate disposal of storm water and sewage.

James Stewart & Company, of Pittsburg, New York and St. Louis, which have constructed many of the buildings of the various Westinghouse Companies, have been the general contractors.

The projectors of the town site enterprise have placed their interests in the hands of the Real Estate Trust Company, of Pittsburg, and under their supervision restrictions have been placed on the sales of property, so that buyers are required to conform to definite regulations as to character and cost of buildings. No liquor of a spirituous nature can be sold within the city limits.

From the knowledge that the public possesses of the substantial character of all the enterprises controlled by Westinghouse interests, it is predicted that this one, the most complete and far-reaching of all, will be the most enduring and reflect most creditably upon all who have been associated with its inception and operation.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

HIGH-SPEED ELECTRIC ROAD FROM BERLIN TO HAMBURG—Despatches from Berlin state that the Prussian Government is satisfied with the speed tests on the experimental electric railway from Marienfeld to Zossen, and is negotiating with the Siemens & Halske Company, of Berlin, for the construction of a high-speed electric line from Berlin to Hamburg.

ELECTRIC COMBINATION ON THE CONTINENT—A combination of electrical companies, it is announced, has been formed on the Continent, the arrangement including the French Thomson-Houston Company, the Mediterranean Thomson-Houston Company, the General Electric Company, of New York, and several important German companies. In New York it is not believed that this statement has any foundation.

NEW YORK CENTRAL TO BUILD ELECTRIC ROADS—It is announced that the New York Central Railroad Company is planning to establish electric roads as suburban branches in the central and western part of New York state, in order to save local traffic which has been heavily cut into by the independent trolley lines. A section of the Rome, Watertown & Ogdensburg Railroad, which is leased to the New York Central, is to be equipped with electricity, and New York Central trolley cars can be run to and from all points along the southern shore of lake Ontario. This project will possibly also absorb the Rochester & Suburban Electric lines. For some time the New York, New Haven & Hartford management has been acquiring electric lines. This company is now operating about 185 miles of trolley lines located in not less than ten widely separated localities.

LIGHT MERGER APPROVED—The consent of a majority of the shareholders of the Johnstown (Pa.) Light, Heat and Power Company and the Citizens' Light, Heat and Power Company has been secured to the proposition for the amalgamation of the interests represented. The Citizens' company becomes the purchaser of the Johnstown company's stock, and will increase its capital to $1,000,000, the holders of stock in the present companies to receive one and one-third shares for each share now in their names. There has been no opposition expressed by the shareholders of either company to the arrangement concluded by the representatives, and it is expected that unanimous consent will be given to the proposition. It is the intention of the management to equip the plants with the most modern and economical apparatus. The low price at which the city will be furnished with street lights will doubtless result in a large increase in the number furnished, and establish a basis for a large business. By a division of the source of supply a great improvement will be made in the domestic service.

PLANS FOR THE PENNSYLVANIA TUNNEL—It is expected that contracts for the Pennsylvania and Long Island tunnels will be given out in December, when work will immediately commence at several points. Preliminary drawing of the plans and specifications has been fully carried out under the direction of Charles M. Jacobs, Alfred Noble and other consulting engineers. Ten million dollars has been expended in buying several pieces of property in Manhattan and Long Island City, and in New Jersey. It is peculiar that the largest part of this property is in the most expensive residence district in the United States. The tunnels will run from Weehawken, N. J., to Long Island City, L. I. The bottoms of the tunnels are to be trenched for two drains, and on each side there are solid concrete trenches containing the electric conduits. The tops of the trenches form horizontal platforms three feet eight inches wide, which provide emergency walks at about the height of the car windows on both sides of the track. The concrete side walls are carried up four and one-half feet above the galleries, and above that point the roof arch is built with five courses of brick held edgewise and banded together by occasional pairs of brick on end. The concrete lining of the land section is water-proofed with one-half inch Portland cement mortar, and six layers of felt and seven layers of coal tar pitch. There are provided all through the tunnels refuge niches and ladders in the faces of the conduit galleries, drawholes and manholes for the high-tension, low-tension telegraph and telephone conduits, and ladders twenty-five feet apart give access from the emergency platforms to the tracks. The refuge niches are the same distance apart and opposite the ladders. At intervals of 300 feet the two tunnels are connected by transverse tunnels about seven feet high and five feet wide, which have their floors at the level of the emergency platforms and are closed by double-leaved padlocked steel-plate doors. The specifications for the entire work call for 11,840 feet of single-track concrete-lined tunnels; 3,840 feet with two or three tracks; 1,670 feet single-track, concrete lined, built in cut and cover; 3,790 feet four to seven-track tunnels in open cut and cut and cover; 1,700 feet three and four-track tunnels with steel truss beams and concrete lining, and 24,049 feet of cast-steel shell single-track shield-driven tunnel, of which 12,174 feet will have screw piles.

CHICAGO CAR GRANT AWARDED—A tentative ordinance for the Chicago City Railway Company has been announced. This contains an absolute waiver of the ninety-nine-year act, a provision permitting municipal ownership at the end of twenty years, and stipulations for immediate improvements in service. The rate of compensation has not been determined upon, but has been left by the subcommittee for the decision of the transportation committee. This body is expected to take up the consideration of the grant after the directors of the City Railway Company have passed upon it. The ordinance is said to be nothing more than a concrete basis upon which the aldermen can base their final compensation negotiations with the president of the company and the company's attorneys. The ordinance is accompanied by exact tables of specifications showing the field of operations and schedules of receipts and earnings for the last three years. These schedules have not been given out. Electricity is named as the motive power for all the company's lines during the twenty years of the grant. All feeder wires carrying a current of more than 1,000 volts are to be laid underground in conduits. Authority is granted for the construction in streets and alleys of these conduits, which are to be four feet wide and three feet high. The city reserves the right to use the conduits for its own wires, paying in such case half the cost of construction. The company will be entitled to charge for a continuous trip in one general direction within the city limits a fare of five cents for every adult passenger and three cents for every child between the ages of seven and twelve years. Children under seven, when accompanied by a guardian, shall ride free. Each passenger will be entitled to a transfer slip permitting him to continue his journey in the same general direction, but not to reverse it. A transfer upon a transfer may be granted to permit a passenger to reach his destination. The company also bonds itself to make a transfer agreement with the company that may in future receive the franchise for operating the lines on the southwest side, thus permitting the residents in that district to make a continuous trip up and down town for one fare. The city is granted the right to use the trolley poles of the company to carry its signal, telegraph, telephone and electric light wires and lamps. The poles are to be not less than 115 feet apart, constructed of iron or steel, ornamental in design, and kept well painted. All new track hereafter laid in any paved street shall be of the grooved type, known as the Trilby rail, and weighing not less than 100 pounds to the yard. Such rails shall also be laid in renewing worn-out tracks, but it is provided that the company shall not be compelled, on account of the repaving of the street, to remove good, serviceable rails of the old pattern which have not seen ten years' service. In unpaved streets the girder type of rail may be used. The company shall, upon the request of the city council, extend its street car system in any street for which an ordinance may be passed in the future. The company shall not be required, however, to construct more than six miles of track during one fiscal year, and it is also required that at least 150 families reside in each half mile of a new route.

ELECTRICAL SECURITIES.

The speculative community is still hopeful despite the check of last week to the recent advance in prices. A number of adverse developments and the general outlook, particularly the financial unsettlement at St. Louis, following similar difficulties at Baltimore and Pittsburg, exerted a check on the market, and the probability of further difficulties in other interior points is not impossible. The market, however, remains significant in its resistance to bad conditions of this nature. While prices have not advanced, it is remarkable that they have not furtner declined. It is expected that a firm money market will prevail for some time, but there is no expression that this will bring about any stringency. The banks are in a stronger position than is usual at this period of the year and the prospects of aid from gold imports from abroad are also very good.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 31, 1903.

New York:	*Closing.*
Brooklyn Rapid Transit	35¼
Consolidated Gas	174½
General Electric	148½
Kings County Electric	150
Manhattan Elevated	135¼
Metropolitan Street Railway	109¾
New York & New Jersey Telephone	142
Westinghouse Manufacturing Company	160

The earnings of the Brooklyn Rapid Transit Company for the fiscal year (beginning July 1) to October 19, are $4,594,230, as compared with $4,097,598 for the same period of 1902, an increase of $496,632. From October 1 to October 19 the earnings were $712,552—an average of $37,503 per day, as compared with $656,273 in the same period last year, or an average of $34,541 per day.

The directors of the Consolidated Gas Company have declared the regular quarterly dividend of 2 per cent, payable December 15. Books close November 25 and reopen December 16.

Boston:	*Closing.*
American Telephone and Telegraph	126
Edison Electric Illuminating	235
Massachusetts Electric	77½
New England Telephone	124
Western Telephone and Telegraph preferred	80

Directors of the New England Telephone and Telegraph Company have declared a regular quarterly dividend of 1½ per cent, payable November 14. Transfer books closed November 2 and reopen November 14.

The instrument statement of the American Telephone and Telegraph Company for the month ending September 20 shows gross output of 79,406, and 33,438 returned, leaving a net output of 45,968, as compared with 41,677 in 1902, and 42,096 in 1901. Since December 20, 1902, the gross output has been 812,229, and 358,831 have been returned, leaving a net output of 453,398, as compared with 461,645 in 1902 and 381,882 in 1901. The total outstanding is now 3,603,718, as against a total of 2,987,251 in 1902, and a total of 2,334,698 in the preceding year.

Philadelphia:	*Closing.*
Electric Company of America	7⅜
Electric Storage Battery common	47
Electric Storage Battery preferred	47
Philadelphia Electric	6
Union Traction	43⅞
United Gas Improvement	79½
Chicago:	*Closing.*
Chicago Telephone	117
Chicago Edison Light	140
Metropolitan Elevated preferred	56
National Carbon common	17
National Carbon preferred	88½
Union Traction common	7
Union Traction preferred	32

AUTOMOBILE NOTE.

The annual meeting of the Automobile Club of America will be held at the club house, 753 Fifth avenue, on Monday, November 16, at 4.30 o'clock in the afternoon. The governors, pursuant to the by-laws, have nominated the following ticket to fill the vacancies named: President, Winthrop E. Scarritt; first vice-president, Henry Rogers Winthrop; second vice-president, Harry Payne Whitney; third vice-president, William K. Vanderbilt, Jr.; treasurer, Jefferson Seligman; three governors to serve three years (class of 1906), Dave H. Morris, Sidney Dillon Ripley, Albert R. Shattuck; two governors to serve one year (class of 1904), Harlan W. Whipple, Arthur Iselin.

PERSONAL MENTION.

DR. WILLIAM A. COLLEDGE has been appointed dean of the American School of Correspondence at Armour Institute, Chicago.

MR. HENRY DAVIS, of Tilton, N. H., has been appointed superintendent of the Citizens' telephone system at Tilton and Franklin, N. H.

MR. E. J. KENNEDAY has been appointed principal assistant engineer of the Tennessee Construction Company, with headquarters at Clarkesville, Tenn.

DR. C. K. EDMUNDS, Ph. D. (Johns Hopkins), has been appointed professor of physics and electrical engineering at the Christian College, in Macao, China.

MR. J. M. MARTIN has tendered his resignation as district sales agent at the Philadelphia office of the Nernst Lamp Company. Mr. A. E. Baker has been appointed as his successor.

MR. E. M. WALKER, of Boston, Mass., recently accepted the position of general manager of the Bristol Gas and Electric Company and the Bristol Belt Line Railway Company, Bristol, Tenn.

MR. JAMES P. CLARK has been appointed general manager of the Wabash-Logansport (Ind.) traction lines and the Fort Wayne city lines, with jurisdiction over the Fort Wayne & Southwestern road.

MR. NORMAN G. KENAN has been elected president of the Cincinnati Gas and Electric Company, Cincinnati, Ohio, to succeed General Andrew Hickenlooper, who resigned on account of ill health.

MR. FRANCIS R. WELLER has resigned his position with the engineering department of the District of Columbia and is now associated with Henry A. Pressey, civil and hydraulic engineer, Washington, D. C.

MR. JOHN KISSICK, chief electrician of the Kearsarge, one of the United States battleships, is a native of Paisley, Ontario. He was recently offered a reengagement on the Kearsarge, but thinks of going into electrical engineering.

MR. CHARLES E. FARRINGTON, treasurer of the Massachusetts Chemical Company, Boston, Mass., has just returned from a trip abroad. Mr. Farrington stopped in New York city last week, making his headquarters at the Manhattan Hotel.

MR. FRANK G. BOLLES, formerly manager of the export and foreign department of the Bullock Electric Manufacturing Company, Cincinnati, who has been abroad for some time, recently returned home to Cincinnati, Ohio. Mr. Bolles is no longer connected with the Bullock company.

MR. R. G. SEIGEL has been appointed signal engineer of the elevated lines of the Brooklyn Heights Railroad, Brooklyn, N. Y. Mr. Seigel began his railroad service on the Chicago & Northern Pacific in 1890, and later he went to the Boston elevated, which position he now leaves to go to Brooklyn.

MR. ARTHUR FORTH, who has been manager for the Southern Illinois Telephone Company, Effingham, Ill., has tendered his resignation to accept the position of general superintendent of construction for the Central Union Telephone Company. Mr. T. Turner will succeed Mr. Forth as manager of the Southern Illinois Telephone Company.

MR. C. N. MONEY, of the Union Electric Company, Baltimore, Md., is in New York in the interests of his company. The Union Electric Company is the eastern agent for the Victor Electric Company, of Chicago, Ill., manufacturer of electrical surgical specialties, and Mr. Money reports a very encouraging demand for the latter company's apparatus.

MR. ARTHUR WILLIAMS has consented to remain another year in charge of the department of sign and decorative lighting, and will prepare a new report for presentation at the twenty-seventh convention of the National Electric Light Association, to be held in Boston next May or June. Through the cooperation of the New York Edison Company, the report presented at the Chicago meeting has been printed and distributed without expense to the association.

ELECTRIC LIGHTING.

MOHAWK, N. Y.—This city has voted $30,000 for the purpose of installing an electric light plant.

ATLANTA, GA.—The city of Douglas has voted to issue $20,000 for waterworks and an electric light plant.

GALVESTON, TEX.—The Houston Light and Power Company is to spend $185,000 on extensions and betterments.

MASON CITY, IOWA—James Rule and others have asked for a franchise for an electric light and heating plant.

TELL CITY, IND.—The council has purchased the electric light plant of the Tell City Electric Light Company, paying $10,700 for it.

KENTLAND, IND.—The power station of the Kentland Electric Light Company has been destroyed by fire, entailing a loss of $7,000.

SANBORN, IOWA—Work has been commenced on the building of the Sanborn electric light plant. It is to have a capacity of 2,500 lights.

NORTH TONAWANDA, N. Y.—Work has been begun on the erection of two new additions to the plant of the Niagara Light, Heat and Power Company.

BRUNSWICK, ME.—The buildings and machinery of the Thomaston Electric Light Company were destroyed by fire recently, entailing a loss of $25,000.

YORK, PA.—The light committee has awarded the contract for street lighting to the Edison Electric Light Company for one year, at eleven cents per light per night.

NEENAH, WIS.—It is said that a special election will be called to determine the wishes of the people in the matter of municipal ownership of an electric plant. A stock company of local capitalists stands ready to put in a $50,000 plant.

KOKOMO, IND.—Ground has been broken for the new power station of the Marion & Western Traction Company. The work on the building will be rapidly pushed, as it is the intention of the promoters to have it completed by February 1.

WALLINGFORD, CT.—The annual report of the board of electrical commissioners shows the receipts of the borough electric plant for the year to have been $19,657.09, and the operating expenses, $14,847.38, leaving a profit for the year of $4,969.25.

TERRE HAUTE, IND.—Plans have been completed for the new power-house of the Terre Haute Electric Company, of Terre Haute, Ind., which will lost $200,000. Work will probably be started in the spring, and it is hoped to have the plant in operation before next winter.

FAYETTEVILLE, N. C.—The Cape Fear Electric Power Company is pushing work on its plant at Buckhorn Falls, on the Cape Fear river, and it is expected that the wires will be running into the city by the end of the winter. The company is said to have secured several large contracts for power.

TRENTON, N. J.—The Washington Electric Light Company's plant, which has been owned and operated for the last three years by a company of Wilkesbarre, Pa., capitalists, has been sold to Harry Reed, of New York city. The price paid is said to have been $25,000. It is stated that Mr. Reed will spend several thousand dollars for improvements.

SHAWNEE, O. T.—The Shawnee Electric Light and Power Company has sold its plant to a number of capitalists who are represented by J. J. Henry, of Denver, Col. The consideration is said to have been $125,000. A large new power-house was recently completed and is now being equipped with new engines. This will be ready for operation in a short time.

WEST PALM BEACH, FLA.—The East Coast Electric Light, Power and Ice Company has been formed to carry on the business of the West Palm Beach Electric Light and Power Company, having purchased the franchise and good will of the latter. The company has also purchased two other plants, one at Fort Pierce, and will make many improvements to its property.

ITHACA, N. Y.—Ground has been broken at Taughannock Falls for the new power station which is to be built by the Trumansburg Electric Lighting Company, and work will be pushed so as to have the plant completed by the first of December. The company has secured water rights along the stream for a distance of three-quarters of a mile, and a dam twenty feet in height will be erected.

COLUMBUS, GA.—At a recent meeting of the trustees of the Catawba Power Company in Rock Hill, S. C., Mr. W. S. Lee, Jr., was elected vice-president and W. H. Martin, Jr., treasurer of the company. The company is developing a large water power on the Catawba river, eight miles from Rock Hill. The plant will not only furnish power to Rock Hill, but also to Charlotte, N. C., twenty miles away.

PITTSBURG, PA.—A new light and power company has been formed at McKeesport with a capitalization of $50,000, which will be known as the East McKeesport Light Company. The company will erect a power plant in East McKeesport in a short time and will operate in that town and in North Versailles township and the Wilmerding Valley. The company has been granted a franchise by the borough council of East McKeesport.

TOLEDO, OHIO—It is stated that Detroit and Wyandotte business men contemplate the formation of a company for the development of the water power of the Huron river. This stream is located midway between Monroe and Detroit. Flat Rock is situated on the river. A company capitalized at $250,000 is talked of. The company expects to furnish electric power to the Detroit, Toledo & Monroe electric car line, north of Monroe.

VANCOUVER, BRITISH COLUMBIA—The Vancouver Electric Light and Power Company has put in another boiler of 100 horsepower, and will furnish power for the contractors who are building the Portland dry dock. The work requires steam hammers and drills and other machines, and the electric light works being adjacent the power can be furnished at small expense. Later on the boiler will be used in the furnishing of additional lights.

BATTLE CREEK, MICH.—The Kalamazoo Valley Electric Company, of Kalamazoo, has filed a trust mortgage with the register of deeds in favor of the American Trust and Savings Bank of Illinois for $100,000. The mortgage is dated October 1, 1903, and is to run for twenty years at six per cent interest. The mortgage is given for the purchasing of the rights of the Jackson & Battle Creek Power Company, Limited, between Battle Creek and Jackson.

WASHINGTON, D. C.—The annual report of Walter C. Allen, electrical engineer for the District of Columbia, shows that 9.4 miles of underground cable, containing 282.85 miles of wire, was laid during the year. The total number of miles of underground cable now laid in the District is 21.58, aggregating 1,046.20 miles of conductor. The work of changing the system of arc lighting from the old-style open-series lamps to those of the enclosed type was completed during the year.

BRISTOL, VA.—The United Gas and Electric Company, of New York, has purchased the property of the Bristol Belt Line Railway Company, as well as that of the Bristol Gas and Electric Company and the Bristol-Goodson Water Company. The new company, which owns similar properties in a number of cities of the United States, announces that it will extend the electric car line and will also provide a new water supply for the city, the cost of which will probably not be less than half a million dollars.

NEW INCORPORATIONS.

SAN SABA, TEX.—San Saba Ice and Electric Light Company. $15,000. Incorporators: T. C. Henry, J. W. Longley, T. A. Murray, John H. Martin, W. S. Sanderson, G. H. Sanderson and U. M. Sanderson.

DES MOINES, IOWA—Iowa City, Kalona & Washington Railway. $50,000. Incorporators: George G. Rodman, W. P. Coast, C. W. Keck, A. N. Alberson, George W. Wagner, U. G. Smith, George S. Carlson, C. S. Welch, S. W. Brookhart.

GUTHRIE, OKLA.—The Lawton, Wichita Mountain & Western Electric Railway Company. $220,000. Incorporators: C. W. Johnson, of Montgomery, Ala.; S. P. Brunbage, of St. Louis; J. R. Brattan, of Carthage, Mo.; Edward F. Mitchell, of El Reno; D. R. Rankin, R. A. Hubard, Charles Mitscherick and J. H. Russell. To build a road running from Lawton to Fort Sill and northwest from Lawton to Lone Wolf, penetrating the entire Wichita mountain system.

ELECTRIC RAILWAYS.

VINCENNES, IND.—Benjamin G. Hudnut, of Terre Haute, has sold his Vincennes street railway to the E. M. Dean Syndicate, of Grand Rapids, Mich., for $100,000.

CORRY, PA.—A company has been formed to build a trolley line between this city and North East, a distance of thirty-five miles. This line will touch Findlays lake and cut into Chautauqua County, N. Y., and open up a territory which has no railroad facilities.

EUFAULA, ALA.—A franchise has been granted by the city council to the Eufaula Railroad Company, which is composed of J. B. Foy, B. B. McKenzie, R. A. Ballowe, C. A. Martin, H. C. Holleman and A. L. Brassell. An electric railway is to be built in the city and also as far as Abbeville, about twenty-five miles.

AKRON, OHIO—At a meeting of the directors of the Northern Ohio Traction and Light Company it was decided to build an electric line from this city to Massillon over the right of way purchased and partly graded before the failure of the Everett-Moore Syndicate. The directors authorized the officials to proceed with the work as early next spring as practicable, and it is believed that the line will be open and in operation by the middle of next summer.

CAMDEN, N. J.—The Camden & Suburban Railway Company and the officials of the borough of Haddonfield have adjusted their differences, and the double-track trolley line from Haddonfield to Haddon Heights will be commenced at once. When completed one line of cars will run to Haddon Heights, thence to Haddonfield and Camden. The Haddonfield line will be operated to Haddon Heights and thence to Camden, thus forming a complete belt line for the residents of the outlying districts.

CADILLAC, MICH.—The Cadillac Traction Company is the name decided upon for the company which expects to build and equip an electric street railway for the city of Cadillac, and to operate the electric light plant and waterworks in connection therewith. The capital has been placed at $250,000. The company's officers are: President, Willis J. Cornwell; vice-president, John F. Vosburg; secretary, George S. Stanley; treasurer, Francis O. Gaffney; superintendent and general manager, J. H. Orr. The company has filed its articles and will soon begin work on its line.

PITTSBURG, PA.—A charter has been granted to the Pittsburg & Butler Street Railway Company. It is proposed to build an electric line from Pittsburg to Butler by way of the Evergreen road, the old Perrysville pike, the Three Degrees road, and then in a direct line to Butler. The line will pass through Evans City, Brush Creek and Zelienople. At the latter place it will connect with the New Castle system of street railways. Among those interested in the plan are Max Klein, John Sauers, Joseph W. Weinburg, Frederick Gwinner and W. W. Wyant, of Allegheny.

COLUMBUS, OHIO—An electric road, connecting Cincinnati and Toledo, passing through Columbus, is projected by the Toledo, Columbus & Cincinnati Railway Company, which has been incorporated by T. A. Wright, C. H. Haedler, Frances J. Bulask, C. L. Held and H. J. Jarvis. The road is to pass through Hamilton, Clermont, Warren, Clinton, Fayette, Green, Pickaway, Madison, Franklin, Union, Logan, Hardin, Auglaize, Allen, Wood, Putnam, Henry and Lucas counties. The nominal capital of $10,000 is named in the incorporation papers.

SPRINGFIELD, ILL.—Articles of incorporation have been issued for the Illinois Central Electric Railway Company, with its principal office located at Canton. The capital stock is $300,000 and the object is to construct a line from Canton, Fulton County, Ill., to Peoria, Peoria County, Ill.; Galesburg, Knox County, Ill.; Havana, Mason County, Ill.; Fairview, Farmington and Lewiston, in Fulton County, Ill., and Macomb, McDonough County, Ill. The incorporators and first board of directors are Joseph David, Cleveland, Ohio; James A. Lawrence and James S. Hopkins, Chicago; Fred A. Dolph, Aurora, Ill.; David J. Peffers, Jr., Evanston, Ill.

ELYRIA, OHIO—It is understood that the Cleveland & Southwestern Traction Company is planning to extend its system from Grafton in a southerly direction to Ashland. The projected road will run parallel to the Big Four to LaGrange, then taking a direct southerly trend it will pass through Penfield Center, Spencer and Homer to West Salem and thence southwesterly parallel with the Erie Railroad to Ashland, with a probable extension to connect with the Mansfield systems in the course of time. The total extent of the line will be about forty miles. Surveying will be commenced at once, it is said, and it is hoped to begin work on the line early next year. To furnish the necessary extra power needed to operate the proposed system a power-house will probably be located at Ashland.

OBITUARY NOTICES.

MR. JOHN C. DANIELS, who was president of the Garton-Daniels Company, Keokuk, Iowa, died October 25, at his former home at Eau Claire, Wis. Mr. Daniels was formerly the owner of a fleet of raft boats operating on the Mississippi river and in 1892 engaged in the business of the Garton-Daniels Company. Mr. Daniels was born in New York state in 1840. He was a man of sterling character and was well known and held in high esteem throughout the electrical field.

PROFESSOR ROBERT H. THURSTON, director of Sibley College, Cornell University, died at Ithaca, N. Y., on October 25. Professor Thurston was born in Providence, R. I., on October 25, 1839. He took the course of civil engineering in Brown University, graduating in 1859 with the degrees of C. E. and P. B., after which the degrees of A. M. and LL. D. were conferred upon him by Brown, and in 1885 the Stevens Institute of Technology conferred on him the degree of Doctor of Engineering. His father, Robert L. Thurston, of the firm of Thurston & Gardner, was one of the early steam engine builders of the country. Professor Thurston worked in his father's shops until the war broke out in 1861, when he received the appointment of assistant engineer in the navy. He served throughout the war in different vessels along the coast and became engineer of one of the Monitors. From 1865 to 1871 he was instructor in the Naval Academy at Annapolis, and in 1871 was called to the professorship of mechanical engineering in the Stevens Institute of Technology. Professor Thurston remained with the Stevens Institute until 1885, when he was appointed director of the Sibley College of Mechanic Arts at Cornell University. He had a brilliant career as a teacher, author, investigator and organizer. He was United States commissioner to the Vienna Exposition in 1873, and an active member of the United States board appointed to test iron, steel, etc., from 1875 to 1878. In 1880 he was one of the founders of the American Society of Mechanical Engineers and was its first vice-president. He was a member of the American Society of Civil Engineers, a fellow and first vice-president of the American Association for the Advancement of Science, and a member of many foreign societies. While in Europe as a member of the jury of the Paris Exposition of 1889, he made the address in response to the address of welcome in the Hall of the Exposition of Civil Engineers in London. Professor Thurston leaves a wife and three daughters, the eldest of whom is married to Professor Coffin, of the University of Wisconsin.

LEGAL NOTE.

SINGLE-PHASE MOTOR LITIGATION—A decision has been handed down in the United States Circuit Court of Appeals for the Second Circuit, in the suit between the Thomson-Houston Electric Company as complainant-appellant, and the Wagner Electric Manufacturing Company and others, as defendants appellee, in favor of the Wagner Electric Manufacturing Company. The case was heard before Circuit Judges Wallace, Lacombe and Cox, and is an appeal from a decree of the Circuit Court of the Southern District of New York, dismissing the bill on the ground that the defendants' device does not infringe the claims of the patent sued on. The original suit was brought on United States letters-patent No. 430,328, of June 17, 1890, granted to Elihu Thomson on an alternating-current motor. It appears that the issue turns on the contention of the defendants that their motor is not an infringement of the complainant's patent, in that the complainant's patent calls for a starting circuit in its motor different from the circuit necessary after the motor has reached its full speed. In the complainant's patent the motor is started with the circuit through the armature commuted, and when running at full speed the armature circuit is locally closed upon itself. With the defendants' motor the motor is started with the armature circuit locally closed upon itself, and does not make use of two circuits, as called for in the complainant's claims. The defendants have asked for a narrow construction of the claims in the complainant's patent, and the present decision confirms that of Judge Townsend, of the lower court, that a narrow construction is necessary and that the defendants' apparatus does not infringe the patents held by the complainant.

INDUSTRIAL ITEMS.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York city, will be pleased to send, upon request, its catalogue No. 16. This contains illustrations and descriptions, as well as a price list, of electrical apparatus of every character.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., announces that the "Zenith" lamp, for which it is the selling agent, is meeting with a high-class demand. Booklets illustrating this lamp will be mailed promptly upon request.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., recently received an order from the Cuyahoga Telephone Company, Cleveland, Ohio, for 8,050 telephones, 5,000 wall sets, 2,500 desk sets and 550 pay station sets. The Kellogg company is building for the same telephone company an 18,000-line board.

THE CROWE METAL MANUFACTURING COMPANY, 71-77 West Jackson Boulevard, Chicago, Ill., announces that it has taken over the entire business of the Bogue & Crowe Manufacturing Company, including good will, and is equipped to fill all orders promptly and guarantee satisfaction.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, is distributing its November calendar card in the series of great men of science and engineering. This contains a portrait and biography of Robert Wilhelm Bunsen. These calendar cards are worthy of preservation.

THE NIAGARA CLIP COMPANY, New York, N. Y., is the New York sales agent for the "Chicago telephone holder." This holder can be placed on any desk and prevents the telephone when being used from disturbing papers lying on the desk. A circular, descriptive of this holder, will be sent on request.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is distributing a unique folder entitled "Long Service." This refers, of course, to the Peerless transformer. The Peerless company is in receipt of numerous letters from light and power companies detailing overload operations of these transformers.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., will mail on application a pamphlet entitled "A Bit of Industrial War History." This relates the contest of a gas *versus* an electric company in one of the central western states, and shows wherein the man who looks well to his power business will be bound to come out on top.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has just issued its November price list and discount sheet. This is an attractive little book designed to supplement its 1903 general catalogue. It has been revised to date and contains the lowest prices in force, and can not help but be of interest to every one in the electrical field; and every holder of a catalogue who has not received this price list should write for one immediately.

W. F. WARNER, Muncie, Ind., is distributing an attractive circular of the Warner arc lamp. This lamp is for direct-current series circuits. The lamps will operate two in series on a 220-volt direct-current circuit, or five in series on a 500-volt direct-current circuit. The Warner lamp is used for lighting the streets of the city of Muncie, 230 in all being operated with three Western Electric and two "Wood" old-style 9.6-ampere machines.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., and Rochester, N. Y., reports that its underground cable department at Rochester is running at its full capacity. A recent shipment of 60,000 feet of underground cable was made to the Keystone Telephone Company, Philadelphia, Pa. It is stated that this cable is a most excellent product. The company has facilities for making cable according to any specification submitted.

THE COOPER HEWITT ELECTRIC COMPANY, 220 West Twenty-ninth street, New York city, is distributing a handsome catalogue descriptive of the Hewitt mercury vapor lamp. Several illustrations are shown, exhibiting the illuminating effect of the Hewitt lamp as an office light, as used in the drafting room, and as used in the machine shop, as well as a number of illustrations of the different types of lamps and apparatus manufactured by this company.

THE HENRY R. WORTHINGTON COMPANY, New York city, is to install at the St. Louis Exposition four twelve-inch, vertical, centrifugal sewerage pumps, each having a capacity of 3,000 gallons per minute and capable of operating against a head of sixty feet. On account of the exposition grounds being partly on a side hill it will be necessary to raise some of the drainage and sewerage by pumping in order to affect its disposal. These pumps will be driven by Westinghouse vertical-shaft induction motors.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, manufacturer of brass and iron engineering appliances, is very busy supplying the trade with Lunkenheimer valves. These are made with an iron body, brass mounted in globe, angle, cross, check and swing check styles, and constructed in screw and flange ends from two inches up. Catalogue will be sent on application. The company has opened a branch office in Paris, France, located at No. 21 Boulevard Voltaire, where it will carry a complete stock of goods.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, Ill., announces the following list of exchanges which it has recently equipped with apparatus of the regular express switchboard as well as the Bell express types of central office equipment: Kingman, Ariz., 150-line express; Trenton, Mo., 100-line express; Chillicothe, Tex., 25-line toll board; Lancaster, Mo., 100-line express; West Point, Ky. (U. S. Signal Office), 50-line Bell express; Elmwood, Ill., 320-line Bell express; Mebane, Mo., 8-line toll board; Everest, Kan., 100-line express.

THE AMERICAN BLOWER COMPANY, Detroit, Mich., is distributing some of the handsomest literature which has been produced this year. Bulletin No. 145 describes and illustrates the "ABC" fan system of heating and ventilating, as applied to manufacturing establishments. Bulletin No. 118 describes a system of mechanical draft, forced and induced by blowers and exhaust fans. Bulletin No. 155 describes and illustrates steel plate fans; and two smaller bulletins describe and illustrate, respectively, the moist air dry kiln and other apparatus for heating and ventilating service.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., is sending out a leaflet containing a letter from Mr. H. W. Hamblin, general superintendent of the Nassau Light and Power Company, of Roslyn, L. I. This is very commendatory of Pittsburgh transformers. The company has been using Pittsburgh transformers almost exclusively for two years, having a total of about 300 in use ranging in size from one kilowatt to fifty kilowatts. Insulation and core tests after two years continuous service have been particularly satisfactory, and out of the 300 transformers only one was lost by burning out and this was attributed to the fact that it had been operating without oil. In some cases, the company has been compelled to subject these transformers to severe usage, overloading up to sixty per cent in excess of the rated capacity. Some of these, which have been watched very carefully under these circumstances, have been found to operate well within safe temperature limits. The Pittsburgh company is also distributing an attractive calendar for November.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has within the past few weeks received a number of notable orders. These have been fairly evenly divided among the larger branch offices, an improving condition of business which is not peculiar to any one section. One order from the Lorain Steel Company, Lorain, Ohio, received through the Pittsburg office, called for forty-one motors, ranging in size from two and one-half to 360 horse-power, and representing a total of 1,423 horse-power. Another large order from the New Jersey Zinc Company, of Hazard, Pa., through the New York office, is for one 125 and two 600-kilowatt generators and thirty-seven motors, aggregating 401 horse-power. The Philadelphia office placed an order from the Warren Foundry and Machine Company, Phillipsburg, N. J., for one 200-kilowatt generator, four thirty-five-horse-power and two sixty-horse-power motors; and through the Chicago office, the G. H. Hammond Company ordered for its packing plant at the Union Stock Yards in that city, 150, 125 and 220-horse-power motors and one 800-kilowatt 550-volt engine-type generator.